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WITH INDEXES
Supplement (87)**

SEPTEMBER 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement (87)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in August 1977 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Special Bibliography* (NASA SP-7037) lists 368 reports, journal articles, and other documents originally announced in August 1977 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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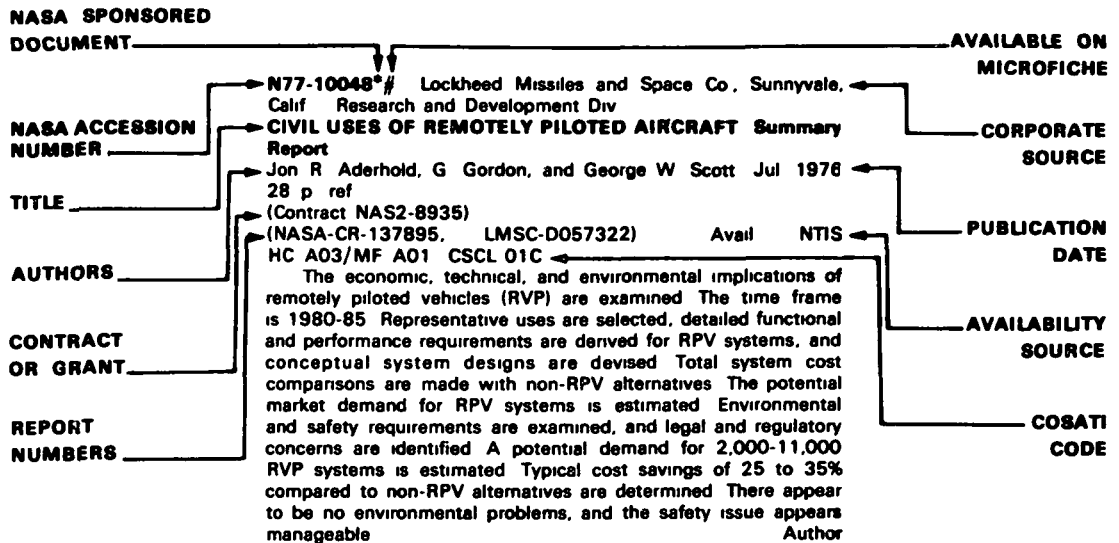
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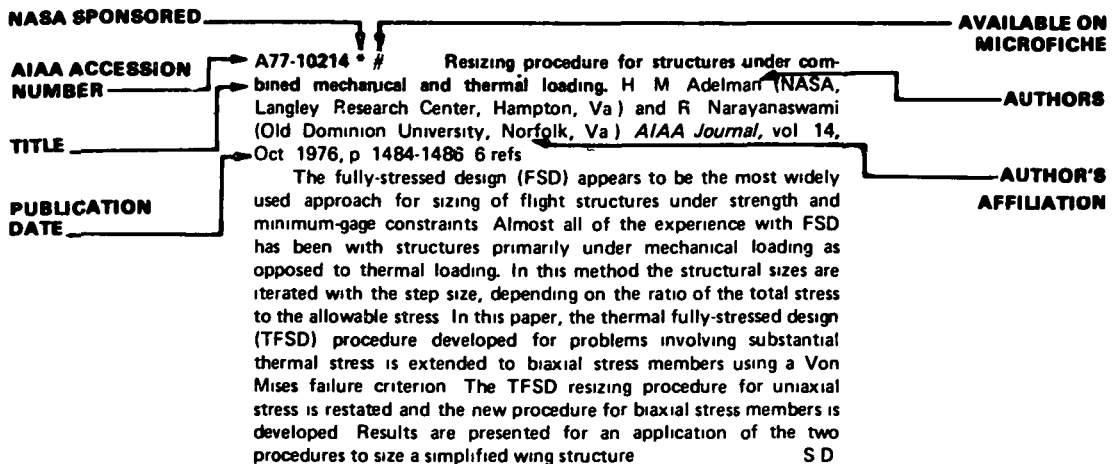
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TYPICAL CITATION AND ABSTRACT FROM IAA



AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 87)

SEPTEMBER 1977

IAA ENTRIES

A77-33575 TFE731 inherits general-aviation fan market. K Fulton *Flight International*, vol 111, May 14, 1977, p 1315-1317

Advantages of the TFE731 turbofan engine are related to low noise and excellent fuel economy. The engine has a relatively high bypass ratio, which is about 2.8:1 for the TFE731-3. No fan inlet guide vanes are employed. The TFE731 first ran in September 1970. A flight test in the starboard nacelle of a modified Gates Learjet 25 was conducted in May 1971. Various versions of the TFE731 turbofan engine have been chosen for more than a dozen business jets. G R

A77-33606 A study of feedback, blade and hub parameters on flap bending due to non-uniform rotor disk turbulence. G H Gaonkar and A K Subramanian (Southern Illinois University, Edwardsville, Ill.) *Journal of Sound and Vibration*, vol 51, Apr 22, 1977, p 501-515. 22 refs. Research supported by the Southern Illinois University.

The paper examines nonuniform turbulence in a rotor disk with reference to hingeless rotorcraft during low lift, high advance ratio operations. The study is based on linear quasi-steady aerodynamics including reverse flow and on the assumption that the flow in the rotor plane is not significantly affected by random vortices shed from the blades. The analytical model concerns a multi-bladed system with rigidly or elastically supported hub and with various feedback control schemes. B J

A77-33614 Underestimated in the West - The MiG-25 Foxbat weapon system. G Panyalev *Interavia*, vol 32, May 1977, p 498-502.

The MiG-25 ('Foxbat') is evaluated as a weapons system and recon vehicle for the medium altitude bracket, on the basis of reconnaissance data and the specimen examined on Hokkaido in late 1976. Data on the MiG 25 family, on MiG-25A characteristics, and on records set by MiG 25 flights, are tabulated. Good marks are awarded to the MiG-25 aerodynamic design, engine, 5-stage transonic compressor, and recon capabilities. While the MiG-25 was originally designed as response to the threat of the (since aborted) U.S. B-70 Mach-3 bomber, the concept is judged a worthy adversary of U.S. combat aircraft of the late Sixties, later versions (up to MiG-25M) 'could represent a danger to the F-14 and F-15'. Its use as bomber or guided missile carrier, and its high-speed interception capability, are taken note of. R D V

A77-33615 Short-term prospects for new commercial aircraft from the USA. J P Geddes *Interavia*, vol 32, May 1977, p 517-519.

The 'shaky state of airline finances' and the 'unforeseeable impact' of impending deregulation are held to account for reluctance on the part of airlines to commit themselves to new aircraft concepts for the short/medium haul range. Pertinent designs advanced by some manufacturers (Boeing, McDonnell Douglas, Lockheed) are compared. No strikingly new technology is expected till the late 80s, active control surfaces and increased use of composites are expected

to meet with obstacles, but interest in a new family of 'cropped fan' or 'clipped fan' engines (30,000-lb thrust or higher) is noted. British, Japanese, and Italian airlines are viewed as waiting to see what experiences American airlines will have in modest innovations in short/medium haul service. R D V

A77-33616 Composite technology - The boom is under way. D J Hoffstedt (Boeing Vertol Co., Philadelphia, Pa.). *Verti-flite*, vol 23, Mar-Apr 1977, p 6, 7.

The state of the art in rotorcraft composite materials and barriers to acceptance of those materials in industry are assessed. Weight-saving goals, cost competitiveness, and research/design requirements are considered. Development status of composites for various rotorcraft subsystems and components are characterized briefly: rotor blades, rotor hubs, landing gear, tail rotor, tail boom, horizontal stabilizer, secondary structure, tail rotor drive shafting, transmission cases, primary airframe, flight control elements, engine components. R D V

A77-33626 Fairing drag and additional drag presented by engines in supersonic flight (Resistenza di carenatura e resistenza addizionale di propulsori in volo supersonico). G Bussi and L Zannetti (Torino, Politecnico, Turin, Italy). *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Politecnico di Torino, Turin, Italy, Sept 30-Oct 3, 1975, Paper 9 p*. In Italian.

An air intake model for supersonic flight is employed in calculating fairing drag and additional drag for various sets of nonsubcritical operation, and recovery of the additional drag is estimated. Inquiry is limited to entirely supersonic flow up to the edges of the intake and outside the fairing. Numerical analysis of the subsonic flowfield around a sharp edge is avoided. Drag calculations are restricted to contributions by pressures, and are extended to the forward part of the fairing where the latter assumes the shape of a truncated cylinder with axis parallel to the flow direction. R D V.

A77-33702 New directions in combustion research as related to jet propulsion systems. I Glassman (Princeton University, Princeton, N.J.) In *Combustion measurements: Modern techniques and instrumentation*, Proceedings of the SQUID Workshop, Purdue University, West Lafayette, Ind., May 22, 23, 1975.

New York, Academic Press, Inc., Washington, D.C., Hemisphere Publishing Corp., 1976, p 3-11, Discussion, p 12-14 refs.

Factors governing new directions in combustion research are considered including the nonavailability of standard fuels and emissions from aircraft. Attention is given to new liquid fuels, turbojet combustor design, aircraft fire safety, combustion problems in ramjets, and turbulent reacting flows. B J

A77-33705 Phenomenology and design of jet engine combustors. R Roberts (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) In *Combustion measurements: Modern techniques and instrumentation*, Proceedings of the SQUID Workshop, Purdue University, West Lafayette, Ind., May 22, 23, 1975.

New York, Academic Press, Inc., Washington, D.C., Hemisphere Publishing Corp., 1976, p 41-59, Discussion, p 59-64. 7 refs.

A building block approach is taken to the modeling of a gas-turbine engine main combustor. The composite model includes

submodels of turbulent mixing, streamtube internal flow field, physical burning, fuel drop evaporation, fuel-air-mixing, hydrocarbon chemistry, temperature rise, change in species concentration, and external air addition
B J

A77-33716 Raman measurements of specie concentration and temperature in an aircraft turbine exhaust. D A Leonard (Computer Genetics Corp., Wakefield, Mass.) In Combustion measurements Modern techniques and instrumentation, Proceedings of the SQUID Workshop, Purdue University, West Lafayette, Ind., May 22, 23, 1975 New York, Academic Press, Inc., Washington, D C, Hemisphere Publishing Corp., 1976, p 203-210 USAF-sponsored research

The laser Raman field experiments described were carried out with an Avco Lycoming T-53 gas turbine combustor, the emissions from which had been thoroughly investigated by conventional methods. The laser transmitter was a pulsed nitrogen laser, and the receiver was a computer-controlled double scanning spectrometer with combined photon counting and synchronous detection. The Raman data obtained were suitable for precise measurement of the major flow species (N₂, O₂, CO₂, and H₂O) over the entire range of engine operating conditions from idle to full power
V P

A77-33750 Reliability of compressor aerofoils R D C Passey (Rolls-Royce /1971/, Ltd., Derby, England) *Progress in Aerospace Sciences*, vol 17, no 1, 1976, p 67-92 64 refs

Mechanical factors affecting aerofoil reliability under normal conditions are discussed. Five features and their interactions are considered: fatigue and related factors, mechanical location and damping, choice of materials, detection of weaknesses and prevention of failures, and amplitude, frequency, and stress considerations and their relationship to aerofoil geometry. Rotor blade and stator blade failures are analyzed, and vibratory tip deflections and frequency effects studied. Vibratory and steady stresses are evaluated with regard to the geometry of aircraft components. Mechanical location, damping and density, materials, and detection of weaknesses are considered
M L

A77-33776 Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Symposium sponsored by the American Helicopter Society. Philadelphia, Pa., American Helicopter Society, 1976 321 p \$25

The papers collected here report on design and testing of advanced rotors for helicopters. Topics covered include improvement of hingeless rotor stability, mode deflection versus force integration in blade stress calculations, review of the hot cycle rotor/wing, the reverse velocity rotor for achieving 300 knots plus hover capability, circulation control flight demonstrator, and aeroelastically adaptive rotor systems
P T H

A77-33777 * # A parametric model study of the noise generated by the aerodynamic interaction of the tail rotor with the wake of the main rotor R P White, Jr., J C Balcerak (Systems Research Laboratories, Inc., Newport News, Va.), and R J Pegg (NASA, Langley Research Center, Hampton, Va.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 43 p 12 refs

Wind tunnel tests were conducted to determine the influence of various parameters on the noise produced by the interaction of the main rotor wake with the tail rotor. Parameters found to be of significance were the location of the main rotor vortex interaction on the tail rotor disk, the direction of rotation of the tail rotor, the lateral tail rotor-fin spacing, and the operating mode of the tail rotor. Of lesser importance were the main rotor thrust coefficient, longitudinal spacing between rotors, and tail rotor-to-main rotor rotational speed ratios. Analysis of the interaction noise characteristics using a simplified representation of the aerodynamic

phenomena occurring during the interaction showed that existing predictive techniques could be modified and extended to predict the pertinent noise characteristics
P T H

A77-33778 # Concepts for improving hingeless rotor stability. R A Ormiston (US Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 15 p 10 refs

Techniques for improving the lead-lag damping of hingeless rotor blades in hover are investigated. Previous results for the isolated rigid blade flap-lag problem are reviewed, and additional results are presented for elastic, torsionally flexible blades. The elastic blade results confirm the basic rigid blade results and, in addition, show the effectiveness of configuration parameters such as twist and droop for increasing the blade lead-lag damping. Preliminary investigation is made of the ground resonance characteristics of a simple, coupled rotor-body configuration. The results indicate that hingeless rotors are much more sensitive to aerodynamic coupling than are articulated rotors and that the isolated rotor-blade analysis is not always valid for evaluating the effects of aeroelastic couplings on the coupled rotor-body system
(Author)

A77-33779 # Blade stress calculations - Mode deflection vs force integration R L Bielawa (United Technologies Research Center, East Hartford, Conn.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 13 p

Two methods for calculating blade stresses from aeroelastic responses, mode deflection and force integration, are described and compared with respect to accuracy and ease of operational usage. Analytic results are presented for a realistic bearingless helicopter rotor configuration which is capable of experiencing concentrated shears and moments at discrete spanwise points on the blade. It is generally concluded that, when properly implemented, the force integration method yields more reliably accurate stress calculations
(Author)

A77-33780 # Benefits of higher-harmonic blade pitch - Vibration reduction, blade-load reduction, and performance improvement. F J McHugh and J Shaw, Jr (Boeing Vertol Co., Philadelphia, Pa.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 11 p 9 refs

Numerous studies have been conducted to determine the effect of higher-harmonic blade pitch on vibration transmitted to the fuselage by a helicopter rotor. Theoretical analysis, in addition to wind-tunnel and flight testing, has shown that higher-harmonic pitch has the potential to reduce specific components of vibration at the expense of blade loads, performance, or the other components of vibration. A reexamination of higher-harmonic pitch effects on vibration was made with a preliminary wind-tunnel test of a hingeless-rotor model that was instrumented for blade loads and total model loads. Analysis of test data was very encouraging and indicated that vibratory shaft axial force can be reduced to zero between advance ratios of 0.3 and 0.5, with slight improvements in performance and blade loads. Vibratory hub moments have also been reduced with no significant effect on blade loads or performance. The benefits of higher-harmonic pitch have been demonstrated and warrant further analysis with improved theory, wind-tunnel testing, and flight testing
(Author)

A77-33781 # Aerodynamic technology for advanced rotorcraft. A J Landgrebe (United Technologies Research Center, East Hartford, Conn.), R C Moffitt, and D R Clark (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 19 p 42 refs

The paper reviews the state of rotary wing aerodynamic technology, examining selected topics in hovering and forward flight aerodynamic technology. These include, for hovering rotor aerodynamics, a brief discussion of hovering technology background, a description of a refined hover analysis which couples the wake geometry to the blade load distribution, and a comparison of available hover methods. In forward flight rotor aerodynamics, the discussion covers rotor variable inflow and wake effects with emphasis on power prediction, unsteady aerodynamics and skewed flow, rotor aeroelastic effects, and rotor/airframe aerodynamics.

P T H

A77-33782 # Aeroelastic analysis of a bearingless rotor. K W Harvey (Bell Helicopter Textron, Fort Worth, Tex.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 12 p.

An analysis of the nonlinear aeroelastic behavior of a bearingless rotor is presented. Correlation of the analysis with a research rotor model is discussed. A computer study is presented to show that the geometry of the control system, including both the spanwise and chordwise location of the pitch-link-to-pitch-horn attachment point, has a major influence on rotor stability. Several other parameters are evaluated regarding their relative importance in designing for rotor stability. (Author)

A77-33783 # The Hot Cycle Rotor/Wing update and review. R E Head (Hughes Helicopters, Culver City, Calif.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 12 p.

The paper discusses the concept, development, present status, and the future of a high-speed VTOL aircraft called the Hot Cycle Rotor/Wing (R/W). Attention is given to wind tunnel tests of the R/W configuration, where severe three-per-rev pitching and rolling moments were encountered during conversion between rotor and wing modes. It was then shown that second harmonic cyclic pitch reduced blade loads in rotor-running flight and also lowered the roll/pitch oscillation during conversion. It was also found that cyclic variation of hub camber could reduce the oscillating 3/rev moments. More development is suggested to incorporate higher harmonic cyclic pitch, circulation control, and composite materials technology to bring the concept to its full conception. P T H

A77-33784 # The evolution of the variable geometry rotor. W R Mantay (U.S. Army, Air Mobility Research and Development Laboratory, Hampton, Va.) and J B Rorke (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 14 p 13 refs.

A systematic program has been undertaken to study the problem of blade/wake geometry and to design a rotor which capitalizes on this problem. The outcome has been the Variable Geometry Rotor (VGR). The paper presents a compilation of research efforts on the VGR, from its conception through the analytical studies, to recent full-scale hover tests. The VGR matrix is described, including theoretical studies with a freely deformed wake, flow visualization and model-scale hover and forward-flight studies, analytical investigations during simulated maneuvers and a full scale hover program. The experimental and theoretical information from the VGR work indicates that when the conventional geometric design criteria of coplanar blades, equal-azimuth spacing, equal blade radius, and equal collective pitch are systematically altered, benefits in rotor performance, acoustics, vibration, and blade loads are possible. (Author)

A77-33785 # X-Wing - A new concept in rotary wing VTOL. R M Williams, R T Leitner, and E O Rogers (U.S. Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md.) In Symposium on Rotor Technology,

Essington, Pa., August 11-13, 1976, Proceedings.

Philadelphia, Pa., American Helicopter Society, 1976 15 p. 14 refs.

The current status of the theoretical and experimental analysis of an advanced Circulation Control (CC), stopped rotor concept called X-Wing is presented. Modifications to classical fixed wing theory to properly represent circulation control aerodynamics and the interference effects of fore and aft swept wings for the stopped rotor mode are discussed. The results generated from this modified theory are compared with experimental results obtained on a model rotor. Theoretical drag estimation of a full-scale vehicle indicates that the total vehicle parasite drag compares favorably with current fixed wing aircraft. Design tradeoffs for the full-scale aircraft show that for missions requiring less than 30 minutes of hover, a vehicle designed without collective pitch is possible. An elastic slot design is also considered and is shown to enhance both transition and fixed wing performance. (Author)

A77-33786 # Cost-effectiveness benefits of a variable diameter rotor system as applied to advanced VTOL aircraft. E A Fradenburgh and N F K Kefferd (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 18 p 6 refs.

Parametric mission analysis comparisons have been carried out among three Telescoping Rotor Aircraft (TRAC) configurations and four conventional helicopter configurations in order to determine mission requirements for which the variable-diameter rotor aircraft are competitive with the fixed diameter configurations. Fleet cost analysis was also performed. The 400-knot stowed TRAC shows the greatest potential for high productivity and low fleet costs, with a calculated fleet life cycle cost 20 percent below the best of the conventional rotor aircraft. P T H

A77-33787 # The Reverse-Velocity Rotor - 300 knots plus hover capability. F J McHugh and R B Taylor (Boeing Vertol Co., Philadelphia, Pa.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 9 p.

The paper describes concept and model testing of the Reverse-Velocity Rotor (RVR), which has been designed to avoid or eliminate phenomena such as compressibility on the advancing tip, reverse flow on the inboard end of the retreating blade, and stall on the outboard end of the retreating blade, which restrict the forward-flight regime of helicopters. The RVR is a slowed rotor with reverse-flow airfoil sections and 2/rev blade pitch. The model tests show that the concept provides a significant improvement in rotor lift capability with no degradation of lift-to-drag ratio. In untrimmed operation, a lift-to-drag ratio of 9.0 can be achieved at an advance ratio of 1.2, or approximately 300 knots flight speed. P T H

A77-33788 # The flexhinge rotor. B White (Bell Helicopter Textron, Fort Worth, Tex.) and W Weller (U.S. Army, Air Mobility Research and Development Laboratory, Hampton, Va.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 10 p.

The paper describes the development of hingeless rotors, from a stiff-inplane to a soft-inplane design. For the latest design, an inplane natural frequency of 0.60 to 0.65 per rev has been found to provide a good compromise between inplane loads and damper requirements. P T H

A77-33789 # Development of the composite bearingless main rotor system. C E Swindlehurst, Jr (U.S. Army, Air Mobility Research and Development Laboratory, Hampton, Va.) In Symposium on Rotor Technology, Essington, Pa., August 11-13, 1976, Proceedings. Philadelphia, Pa., American Helicopter Society, 1976 23 p 6 refs.

Concept, design, and testing of the composite bearingless main rotor system are described. Plans for flight demonstration are discussed. P T H

A77-33790 # Advanced two-bladed rotor systems at Bell Helicopter Textron. D L Kidd, V H Brogdon, and J A White (Bell Helicopter Textron, Fort Worth, Tex) In Symposium on Rotor Technology, Essington, Pa, August 11-13, 1976, Proceedings Philadelphia, Pa, American Helicopter Society, 1976 12 p

The two-bladed rotor system, as it has been incorporated in all production Bell helicopters, is noted for its simplicity and reliability. To adapt this system to future needs, Bell Helicopter Textron (BHT) is actively pursuing two advanced concepts. The first is a bearingless two-bladed main rotor (BMR) system, and the second is a wide chord two-bladed rotor (WCR) with a midspan flapping hinge or flexure. Parallel investigations of both rotor systems are now being conducted at BHT with the possibility that the two concepts will be merged at some future date. This paper discusses the current status, possible advantages, known potential problem areas, and measured results obtained to date. (Author)

A77-33791 # Circulation control rotor flight demonstrator. D R Barnes, G A McCoubrey (Kaman Aerospace Corp., Bloomfield, Conn), and D G Kirkpatrick (US Naval Material Command, David W Taylor Naval Ship Research and Development Center, Carderock, Md) In Symposium on Rotor Technology, Essington, Pa, August 11-13, 1976, Proceedings Philadelphia, Pa, American Helicopter Society, 1976 8 p 7 refs.

The design of a circulation control rotor (CCR) system for flight demonstration on a H-2 aircraft is described. Attention is given to blade design, hub design, control system design, higher harmonic control, and design of the control airflow compressor system. P T H

A77-33792 # Full scale wind tunnel tests of a controllable twist rotor. A Z Lemnios, H E Howes (Kaman Aerospace Corp., Bloomfield, Conn), and W E Nettles (US Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va) In Symposium on Rotor Technology, Essington, Pa, August 11-13, 1976, Proceedings Philadelphia, Pa, American Helicopter Society, 1976 17 p 14 refs. Grant No DAAJ02-72-C-0092

The controllable twist rotor (CTR) principle is based on use of a torsionally flexible helicopter blade with a dual control system. Primary control is supplied through a conventional pitch horn system inboard. Blade twist is controlled collectively and cyclically by an aerodynamic trim tab near the blade tip, thereby providing the capability of optimizing the blade pitch distribution resulting in performance improvement, delayed retreating blade stall, and reduced bending moments and vibration levels. Full scale wind tunnel tests of an experimental CTR were conducted to demonstrate the CTR principle through use of existing hardware, to establish relationships between rotor performance, blade vibratory loads, and control settings, and to compare test results with predictions and with previously tested rotors. The CTR was tested to values of blade lift that are 20 percent higher than those of the H-34 with no stall indication. Further, the dual control schedules established by analysis have been verified experimentally as the optimum mix. (Author)

A77-33793 # Investigation of aeroelastically adaptive rotor systems. G S Doman, F J Tarzanin, and J Shaw, Jr (Boeing Vertol Co., Philadelphia, Pa) In Symposium on Rotor Technology, Essington, Pa, August 11-13, 1976, Proceedings Philadelphia, Pa, American Helicopter Society, 1976 17 p

The paper describes the technical approach being taken to achieve favorable aeroelastic adaptivity of rotor systems to a high speed operating environment. The possibilities of using dynamic twist to achieve more favorable load distributions are studied. Wind tunnel tests investigating the effects of varying pitching moment coefficient and of introducing outboard planform sweep are described. P T H

A77-33794 # The YUH-61A /UTTAS/ tail rotor - Development of a stiff inplane bearingless flexstrap design. J Shaw, Jr and

W T Edwards (Boeing Vertol Co., Philadelphia, Pa) In Symposium on Rotor Technology, Essington, Pa, August 11-13, 1976, Proceedings Philadelphia, Pa, American Helicopter Society, 1976 22 p 5 refs

The paper describes the flexstrap design for a rotor tail using fiberglass composite blades and straps. The main design considerations were simplicity and increased survivability. The effects of the design on stability were analyzed extensively, and test on flag-lag instability and stall flutter are described. P T H

A77-33809 * # Numerical solution of three-dimensional free turbulent shear flows. Y H Oh and J E Harris (NASA, Langley Research Center, Hampton, Va) In Symposium on Turbulent Shear Flows, University Park, Pa, April 18-20, 1977, Proceedings Volume 1 University Park, Pa, Pennsylvania State University, 1977, p 1 17-1 28 22 refs

Numerical results are presented for three-dimensional compressible turbulent jet and wake flows. An alternating direction implicit numerical procedure is used to solve the finite-difference form of the parabolic elliptic Navier-Stokes equations. A coordinate transformation maps the boundaries at infinity into a finite computational domain in order to properly specify infinity boundary conditions as well as contain the downstream growth of the viscous flow field in a fixed computational grid. Turbulence closure is achieved through an algebraic mixing length eddy viscosity model. Numerical results for supersonic flow are presented for an axisymmetric jet, an elliptical jet, an elliptical wake, and two interacting rectangular jets. Experimental data were not available for comparison with the numerical results. However, the results compare well with empirical results for free shear flows. (Author)

A77-33816 # Computations and measurements of two-dimensional turbulent jet impingement flowfields. W W Bower (McDonnell Douglas Research Laboratories, St Louis, Mo), D R Kotansky (McDonnell Aircraft Co., St Louis, Mo), and G H Hoffman (Pennsylvania State University, University Park, Pa) In Symposium on Turbulent Shear Flows, University Park, Pa, April 18-20, 1977, Proceedings Volume 1 University Park, Pa, Pennsylvania State University, 1977, p 3 1-3 8 8 refs. Research supported by the McDonnell Douglas Independent Research and Development Programs, Contract No N00014-76-C-0494

The interaction of the lift jets and the ground is an important consideration with regard to the design of VTOL aircraft. A key element of this ground effect problem is turbulent jet entrainment, which causes otherwise static air to be set into motion and leads to aerodynamic loads on airframe surfaces. As a first step toward gaining an understanding of this phenomenon, a combined theoretical and experimental analysis of two-dimensional turbulent jet impingement flowfields has been undertaken. Both planar and axisymmetric jets in close ground effect have been modeled using the incompressible Reynolds equations in combination with a one-equation turbulence model. Distributions of the flow properties are computed as functions of Reynolds number based on jet exit properties and height of the jet exit plane above ground. For the planar impinging jet, flowfield properties are presented for various flow configurations, and comparisons are made with the computed distributions. (Author)

A77-33822 # Test of second order closure model in a compressible turbulent wake. J P Bonnet and T Alziary de Roquefort (Poitiers, Université, Poitiers, France) In Symposium on Turbulent Shear Flows, University Park, Pa, April 18-20, 1977, Proceedings Volume 1 University Park, Pa, Pennsylvania State University, 1977, p 4 11-4 19 19 refs. Direction des Recherches et Moyens d'Essais Contracts No 75/228, No 76/731

Turbulence measurements in the supersonic wake behind a flat plate held at zero incidence are presented. A constant temperature hot wire anemometer is used to measure the turbulence profiles in the wake for several stations. Adjustment of the model is made by

comparison with experimental results in the case of incompressible wake. The relative importance of different terms is studied on the basis of numerical results. Some production terms which are generally neglected may be larger than 30 per cent of the convective terms and must be taken in account even in the far wake. For the supersonic wake, the agreement is good for mean velocity but rather poor for turbulent quantities. (Author)

A77-33841 * # Boundary layer shear stress in subsonic and supersonic flow. V. A. Sandborn (Colorado State University, Fort Collins, Colo.) and C. C. Horstman (NASA, Ames Research Center, Moffett Field, Calif.) In: Symposium on Turbulent Shear Flows, University Park, Pa., April 18-20, 1977, Proceedings Volume 1. University Park, Pa., Pennsylvania State University, 1977, p. 81-88. 25 refs. Grant No. NCA2-OR165-604.

A wide range of shear stress distributions for turbulent boundary layers is examined. A solution for the shear stress in terms of the mean flow is obtained for the limiting case of large Reynolds numbers. Attention is given to turbulent boundary layer shear stress, zero pressure gradient flow, increasing pressure gradient flow, and decreasing pressure gradient flow. G. R.

A77-33842 # Structure and development of a turbulent boundary layer in an oscillatory external flow. J. Cousteix, A. Desoppe, and R. Houdeville (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France). In: Symposium on Turbulent Shear Flows, University Park, Pa., April 18-20, 1977, Proceedings Volume 1. University Park, Pa., Pennsylvania State University, 1977, p. 89-818. 16 refs.

An unsteady-state turbulent boundary layer is experimentally studied in the presence of an oscillatory free stream. A statistical treatment of data enables separate analyses of the periodic component and the turbulent fluctuation of the velocity measured by means of a hot-wire anemometer. The longitudinal component of turbulence is studied by determining its intensity, statistical distribution, and moments. Variations of the shear stress profiles have been measured and are analyzed. A prediction method based on solutions of the local equations is presented. Two turbulence schemes are used: a mixing-length model and a transport-equation model. An integral method of prediction is also presented. The results of these various methods are compared with the experimental data. (Author)

A77-33849 # Experimental and numerical study of constant diameter ducted jet mixing. P. H. Oosthuizen and M. C. Wu (Queen's University, Kingston, Ontario, Canada). In: Symposium on Turbulent Shear Flows, University Park, Pa., April 18-20, 1977, Proceedings Volume 1. University Park, Pa., Pennsylvania State University, 1977, p. 101-107. 5 refs. Research supported by the National Research Council of Canada.

Measurements of mean velocity and turbulence stress distributions in constant diameter, low-speed, isothermal, air-in-air ducted jet flow have been obtained. The conditions used in the tests were such that no regions of recirculating flow existed in the test-section. The measurements obtained are more extensive and complete than in any previous study. The ability of three commonly used turbulence models to predict the measured results has also been assessed. The turbulence models used were: (1) an algebraic mixing-length model, (2) a single differential equation model, the equation used being for the turbulence kinetic energy, (3) a two differential equation model, the equations used being for the turbulence kinetic energy and the dissipation. These were used in conjunction with a numerical solution of the governing equations. (Author)

A77-33853 # The effect of velocity fluctuations and non-uniformities in the free stream on the boundary layer development. H. U. Meier (Aerodynamische Versuchsanstalt, Göttingen, West Germany). In: Symposium on Turbulent Shear Flows, University Park, Pa., April 18-20, 1977, Proceedings Volume 1. University Park, Pa., Pennsylvania State University, 1977, p. 1035-1041. 7 refs.

The influence of grid generated wind tunnel turbulence was studied. It was found that due to the position of the grids relative to the boundary layer start, a momentum loss in the boundary layer can be added. This effect of large fluctuating velocity components and nonuniformity of the flow at the start of the boundary layer was investigated in detail. The investigations led to some general remarks about the influence of the free stream turbulence level in low speed wind tunnel measurements. (Author)

A77-33857 * # Vortex pairing and organized structures in axisymmetric jets under controlled excitation. K. B. M. Q. Zaman and A. K. M. F. Hussain (Houston, University, Houston, Tex.). In: Symposium on Turbulent Shear Flows, University Park, Pa., April 18-20, 1977, Proceedings Volume 1. University Park, Pa., Pennsylvania State University, 1977, p. 1123-1131. 17 refs. NASA-Navy-supported research.

A description is given of experiments which have been carried out in a circular air jet facility consisting of two settling chambers in sequence. Sinusoidal perturbations in the exit profile are introduced at controlled frequencies and amplitudes with the aid of a loud-speaker attached to the wall of the first chamber. It was found that vortex pairing in circular jets can occur in two distinct modes, including the shear layer mode and the jet mode. Amplitude variations, the conditions for strong vortex pairing, and the spectral evolution downstream are illustrated with the aid of graphs. G. R.

A77-33912 # Investigation of the composition of phenol antioxidants containing zinc dialkylthiocarbamates, used to improve the thermal-oxidative stability of jet fuels. (Issledovanie kompozitsii fenol'nykh antioksidantov s dialkilditiokarbomatomami tsinka, ispol'zuemykh dlia uluchsheniia termooxidatsionnoi stabil'nosti reaktivnykh topliv). T. P. Vishniakova, I. A. Golubeva, N. I. Kisilitsyna, I. F. Krylov, B. A. Englin, and V. V. Sashevskii (Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti, Vsesoiuznyi Nauchno-Issledovatel'skii Institut Neftenoi Promyshlennosti, Moscow, USSR). *Khimiia i Tekhnologiya Topliv i Masel*, no. 5, 1977, p. 28-30. 6 refs. In Russian.

A77-33914 # Investigation of the effectiveness of antioxidant additions to a highly hydrogenated jet fuel. (Issledovanie effektivnosti deistviia antioksiditel'nykh prisadok k reaktivnomu toplivu glubokogo gidrirovaniia). N. V. Tumer, O. P. Lykov, N. I. Kisilitsyna, and R. G. Aukharieva (Moskovskii Institut Neftekhimicheskoi i Gazovoi Promyshlennosti, Moscow, USSR). *Khimiia i Tekhnologiya Topliv i Masel*, no. 5, 1977, p. 51-53. 5 refs. In Russian.

The influence of three antioxidants - ionol, NG-22-46, and zinc dialkylthiocarbamate - on the operational characteristics of highly hydrogenated T-6 fuel was studied experimentally. The optimal concentration of ionol and NG-22-46 additions is found to be 0.005 mass %, and that of zinc dialkylthiocarbamate, 0.01 mass %. V. P.

A77-33915 # Investigation of the factors affecting the determination accuracy of addition concentrations in aviation oils, using the method of thin-film chromatography. (Issledovanie prichin, vliiaushchikh na tochnost' opredeleniia kontsentratsii prisadok v aviatsionnykh maslakh pri ispol'zovanii metoda tonkosloinnoi khromatografii). K. S. Chernova, P. A. Mikhchev, and L. L. Ionova (GosNII ERATGA, USSR). *Khimiia i Tekhnologiya Topliv i Masel*, no. 5, 1977, p. 54-57. 7 refs. In Russian.

A77-33964 Aérospatiale proposes a new family /A.200/ of aircraft, with 120 to 160 seats (L'Aérospatiale propose une nouvelle famille d'avions, baptisée A 200 /120-160 places/). J. Morisset. *Air et Cosmos*, vol. 15, May 7, 1977, p. 15-21. In French.

Two versions of the proposed A 200 family of aircraft are described. The A 200 A would have a fuselage length of 34.8 m and capacity for 135 single-class passengers or 120 passengers if there are two class compartments. The corresponding figures for the A 200 B are a fuselage length of 40.9 m and a passenger capacity of 174 or 160. The two models are extremely similar except for the differences

in fuselage length, and A 200 parts in general show similarity to Airbus components. While the aircraft would originally use currently available engines with 22,000 lb of thrust, later aircraft would incorporate a planned engine with 27,500 lb of thrust. Production of 10 aircraft by mid-1982 and 30 by the end of that year is intended. Economies in manufacture and performance criteria are also discussed. M L

A77-33999 # Investigations on the operational behavior and design of combined compressors with radial or diagonal end stage (Untersuchungen zum Betriebsverhalten und zur Ausführung von kombinierten Verdichtern mit radialer oder diagonalen Endstufe) G Schilg (Dresden, Technische Universität, Dresden, East Germany) and F Rau *Wissenschaftliche Zeitschrift*, vol 26, no 1, 1977, p 151-157. 6 refs. In German.

The paper discusses the design of combined compressors for gas turbines, consisting of an axial compressor with reduced number of stages and a radial or diagonal end stage at the same total pressure ratio as the compressor. Experiments for determining the compressor characteristics of such combined compressors in both variants are described. The studies also concerned the effect of having a diffuser with blades and the effect that the change in length and weight of the rotor has on the critical bending rotational speed. P T H

A77-34123 Shock oscillations in transonic flows (Stoss-schwingungen in schallnahen Strömungen) K Finke (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany) *VDI-Forschungsheft*, no 580, 1977. 39 p. 125 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

Shock oscillations controlled by shock-induced boundary layer separation were observed in steady transonic flows. In flows over symmetric two-dimensional profiles, high-frequency oscillations with small shock amplitudes and low-frequency oscillations with large amplitudes are distinguished. Which type of oscillation appears depends on the shock Mach number. Alternating separation and reattachment of the flow on the leading edge is the most intensive form of shock oscillation on profiles at angle-of-attack. The transonic transversal flow past circular cylinders is found to have considerable similarity to the shock oscillations on thick circular-arc profiles. Methods of suppressing shock oscillations are described. P T H

A77-34126 Japanese pushing flying boat designs R G O'One *Aviation Week and Space Technology*, vol 106, May 16, 1977, p 45-47.

A family of large seaplanes under study is outlined, with information on expected cost, various models, safety, aerodynamics, structures, range, and payload. A triple-deck flying boat carrying 1200 passengers over an ocean range, and powered by six high bypass ratio turbofans (77,000 lb thrust each), with upper surface blowing flaps for STOL capability is considered along with a medium-sized amphibian (four 30,000-lb-thrust turbofans), a similar medium-sized amphibian, and a light amphibian (two turbofans, 40 passengers) for island-hopping service. High airport costs are a prime stimulus. Measures to deal with splash, spray, water shock, and submerged or floating objects are discussed. Advantages of open water and three-dimensional area navigation in approach and touchdown, harbor congestion problems and in-port maneuvering, and air cushion landing options are also mentioned. R D V

A77-34302 Aircraft manufacturer warranties - Protection for the manufacturer or the purchaser H Hughes *Air Law*, vol 2, no 2, 1977, p 71-81. 34 refs.

Legal decisions enabling aircraft manufacturers to avoid liability for defects in aircraft sold to airlines are discussed. Cases analyzed include actions grounded in strict tort liability, actions alleging negligence, actions based on implied warranty, and actions based on the express warranties in the purchase agreement. In commercial situations, disclaimers of tort liability have often been found not to violate public policy, the decisions apparently based on the policy rationale that business concerns must be allowed to assign the risk of

loss to one of the parties to the contract and allocate the price accordingly. Sometimes when an express warranty is breached the manufacturer is liable only for replacement of the defective part even if extensive aircraft damage was caused by the defect. The implications of permitting a company to contractually excuse itself from liability from its own tortious acts are considered. M L

A77-34307 ICAM - Revolution in manufacturing M D Zimmerman *Machine Design*, vol 49, May 26, 1977, p 86-91.

Integrated Computer Aided Manufacturing (ICAM) is a system that uses computers to organize every step of manufacturing - from parts design to physical location of machine tools to shipping - in an economical and efficient mode. The system, a response to the proliferation of unrelated computer systems that sometimes cause extra problems in manufacturing, is scheduled for completion by late 1981. The planning and development process is described. Task I calls for developing an architectural model that blueprints various manufacturing complexities. Task II concerns group technology, in which parts and processes are grouped according to common features. Since ICAM is initially geared toward the batch manufacture of aircraft parts that require metalworking processes, Task III involves the assessment of sheet-metal formability and assembly technology. Flow charts and organization tables are displayed. M L

A77-34464 # Streamline curvature in the passage of aerofoil blade cascade. K D Shrivastava (M & A College of Technology, Bhopal, India) (*Institution of Engineers /India/, Meeting, Jaipur, India, Nov 13, 14, 1976*) *Institution of Engineers (India), Journal, Mechanical Engineering Division*, vol 57, Jan 1977, p 179-182. 11 refs.

On the basis of a model of the vortex flow in an axial turbomachine in which the velocity is represented by a series in powers of $1/R$, an implicit expression for the variation of streamline curvature along the equipotential line in a blade passage of a cascade is obtained. The expression satisfies the boundary conditions on both the pressure and the suction surface of a blade. It contains a logarithmic term which can be assumed constant in an approximation. P T H

A77-34476 Environmental aspects of airport development. A H Stratford (Alan Stratford and Associates, Ltd, Woking, Surrey, England) *Airport Forum*, vol 7, Apr. 1977, p 13, 14, 16, 18, 20. 7 refs. In English and German.

Incorporation of noise nuisance assessments in planning of airports is discussed. The article addresses the need to evaluate expected traffic flows, noise levels of future aircraft (as announced by manufacturers), legislative restrictions on noise level, and the need for feedback from airport planners to industry and government on airport area noise loadings. Noise nuisance criteria are compared. Economic disadvantages of nighttime airport curfews are examined. Data on air pollution by airport operations are deemed inadequate. Noise associated with general aviation and training flights at smaller airports is also considered. R D V

A77-34477 Fibrous concrete for airport pavements. J L Rice (FAA, Office of Airports Programs, Washington, D C) *Airport Forum*, vol 7, Apr 1977, p 39-41, 43, 46, 47. In English and German.

The article covers mixing and production of fibrous concrete as airport pavement material, bonding of the material to an existing concrete pavement, and cases of successful applications at various airports. Special applications such as an overlay course (over existing pavement) are recommended for the present state of the art and present costs of the material. Conventional concrete laying and curing techniques are applicable, broom finishes are recommended for texture. Greater ultimate strength, increased toughness, improved spalling resistance, and load-carrying even after cracking are weighed against cost, workability, and problems with fiber clumping. R D V

A77-34479 One autowalk - Two directions New means of transport at Frankfurt airport. H Heusler *Airport Forum*, vol. 7, Apr. 1977, p. 66, 68, 70 In English and German

Electrical controls and mechanical equipment for a moving walkway, or autowalk, facilitating horizontal movement of passengers over extended distances in the airport terminal area at Frankfurt are described. The endless conveyor turns at the ends of the travel and continues motion in the opposite direction. Three autowalk variants are available: a convex/concave semicircular pallet arrangement, a single-chain variant, and a two-chain variant. The two chains are independently tensioned and driven by spring-loaded sprockets. Dimensioning of the moving and stationary parts, turning arcs, and safety devices are described. R D V

A77-34480 # Effects of secondary flows in straight cascades (Effets des écoulements secondaires dans les grilles d'aubes rectilignes) G Meauzé (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Réunion sur les Écoulements Secondaires dans les Grilles d'Aubes, The Hague, Netherlands, Mar 28-30, 1977) ONERA, TP no 1977-29, 1977 6 p In French

Secondary flows in straight cascades play a considerable role, and jeopardize the validity of the tests performed on this experimental set-up, especially at high compression rate, when the secondary flow may fill a relatively important part of the interblade channels. In order to palliate this difficulty, a system of lateral boundary layer suction has been developed. It permits the elimination of the secondary flow and the definition of a primary flow practically uniform over the whole cascade width. The results obtained are satisfactory in subsonic, transonic and supersonic flow, with or without simulation of section convergence. (Author)

A77-34481 # Influence of initial distortions on secondary flows in a fixed annular cascade (Influence de distorsions initiales sur les écoulements secondaires dans une grille d'aubes annulaire fixe) J Huard (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Réunion sur les Écoulements Secondaires dans les Grilles d'Aubes, The Hague, Netherlands, Mar 28-30, 1977) ONERA, TP no 1977-28, 1977 8 p 6 refs In French. Research supported by the Direction des Recherches et Moyens d'Essais

This experimental study was carried out on a test rig comprising, in a cylindrical duct of constant height, an accelerating cascade providing a gyrating flow at high subsonic Mach number and a receiving cascade representing the downstream stator of an axial compressor deflecting the flow back to the axial direction. In the reference configuration, the flow is azimuthally uniform at the inlet. By means of angular sectors of screens with different permeabilities, a pressure drop is created upstream of the first cascade. Examination of the flow between the two cascades reveals a strong perturbation near the hub, where the azimuthal variation of the tangential component induces a transformation of the flow, whose static pressure was initially variable in both radius and azimuth, into one with only radial pressure variation. It is this flow that impinges on the decelerating cascade, which amplifies the secondary effects near the hub where intense flow separations take place. (Author)

A77-34489 Fire testing of aircraft cabins F E Duskin (Douglas Aircraft Co., Long Beach, Calif.) *Journal of Fire and Flammability*, vol 8, Apr 1977, p 193-201

A major aircraft corporation is currently engaged in aircraft fire-safety research and development programs. This effort includes full-scale fire testing of configurations representing commercial aircraft interiors. These tests are being conducted in a Cabin Fire Simulator (CFS), a double-walled steel cylinder 12 feet in diameter and 40 feet long equipped with a ventilation system, exhaust scrubber, and a nitrogen extinguisher system. An on-site computer is used to record thermal and gas-analysis data. Many series of tests have been conducted, one of which culminated in a full cabin lavatory fire test. Subsequent testing of lavatory modules has demonstrated the fire resistance of contemporary materials and the effectiveness of design improvements. (Author)

A77-34525 Exclusive study finds that airport X-ray inspections may cause damage to film J A Rupkalis *Functional Photography*, vol 12, May 1977, p 28-33, 40 5 refs.

A77-34633 Secondary radar Fundamentals and instrumentation P Honold Berlin, Siemens AG, London, Heyden and Son, Ltd., 1976 223 p 9 refs Translation \$19

An introductory text on secondary surveillance radar in ATC systems for engineers and technicians whose specific backgrounds are other than telecommunications. Basic principles of SSR systems and the problems they solve, interrogator design, secondary radar transponder, and some SSR applications are the main topics discussed. Specific topics covered include SSR coding, evaluation and display of response data, antennas, sidelobe suppression, garbling and defruiting, reliability, and the design of some specific interrogators and transponders. A glossary of terms and expressions common in SSR practice is appended. R D V

A77-34874 Air route surveillance radar N Igasaki, M Osaki, A Akaishi, and K Saito (Tokyo Shibaura Electric Co., Ltd., Komukai Works, Kawasaki, Japan) *Toshiba Review*, Mar-Apr 1977, p 5-8

A new air route surveillance radar system, designed for automatic air traffic control, is reported. This system, which can monitor further than 375 km horizontally and more than 21 km vertically, is described as an L-band high-power klystron radar with improved clutter suppression techniques. A block diagram of the system is presented and the component parts are discussed. M L

A77-34926 * V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers Conference sponsored by the American Institute of Aeronautics and Astronautics and NASA New York, American Institute of Aeronautics and Astronautics, Inc., 1977 325 p Members, \$35, nonmembers, \$45

Papers are presented on practical aspects of commercial STOL operations, a Vertical Attitude Takeoff and Landing (VATOL) program, powered-lift STOL ground effects, conceptual design studies of Navy Type A V/STOL aircraft, and a V/STOL shaft propulsion system analytical performance model. Also considered are the management of swirling flows with application to wind tunnel design and V/STOL testing, flight control testing of the VAK-191B, and surface fluctuating pressure measurements on a 1/4-scale YC-14 boilerplate model. B J

A77-34927 # A deflected slipstream aircraft of the sixties /Breguet 941/ and its contribution to the solution of some STOL problems J Czinczenheim (Avions Marcel Dassault-Breguet Aviation, Paris, France) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 1-8 11 refs (AIAA 77-565)

After a short review of the design requirements, development and some operational data of the Breguet 941 STOL aircraft, various performance and handling quality problems related to low speed flying are discussed. Some of these problems, also faced by modern turbofan equipped STOL aircraft, and their solutions as applied to the Breguet 941 are presented. It is pointed out that with the advances in various technology areas significant performance improvements and more accurate stability and control system design are now possible. (Author)

A77-34928 # The Advanced Medium Short Take Off and Handling Transport prototype and development programs C O Schaum (USAF, Systems Command, Wright-Patterson AFB, Ohio) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 9-11 (AIAA 77-566)

The purpose of the Advanced Medium STOL Transport (AMST) program is to support the future tactical airlift requirements of the U S Army. The paper considers the benefits and current status of

the AMST prototype and development programs with particular attention to the YC-15 aircraft B J

A77-34929 # Practical aspects of commercial STOL operations R B McIntyre, A F Toplis, and J H Nazareth (de Havilland Aircraft of Canada, Ltd, Downsview, Ontario, Canada) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 12-19 6 refs (AIAA 77-567)

The feasibility of commercial STOL passenger transport is discussed with reference to experience gained during Airtransit STOL service between Ottawa and Montreal. A simple forecasting model to predict STOL penetration in new markets is applied to two networks, one centered on Chicago's Meigs Field, the other on the Toronto Island Airport B J

A77-34930 # Military airlift application of STOL technology P Bay (USAF, Military Airlift Command, Scott AFB, Ill) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 20, 21 (AIAA 77-568)

As a result of V/STOL research, Military Airlift Command (MAC) has been afforded the opportunity to affect a quantum improvement in the execution of its tactical airlift mission. Some key mission aspects revolve around several fundamental issues in which STOL technology plays a vital role. The issues which involve the latest takeoff and landing performance are delivery of equipment and supplies as close as possible to the eventual user for timely logistical support, the mobility of combat units into and out of their areas of combat responsibility, dispersion of operations from main airdromes to reduce the aircraft's vulnerability to destruction, operations from degraded main runways and a wide variety of semi-prepared austere fields to insure sustained air operations, and improvement of the overall logistics systems efficiency in terms of performance and cost (Author)

A77-34931 # Tethered hover tests of the XBQM-108A vertical attitude takeoff and landing demonstration vehicle. W H Eilertson (US Naval Material Command, David W Taylor Ship Research and Development Center, Bethesda, Md) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 22-30 6 refs (AIAA 77-570)

Vertical attitude takeoff and landing (VATOL) offers an attractive solution to the launch and recovery of Navy RPVs as well as future manned V/STOL aircraft aboard ships. This paper reviews the DTNSRDC VATOL program with attention given to the demonstration vehicle, guidance and control, aerodynamic characteristics in hover, and jet vane performance. Particular attention is given to flight simulation-hover flight phase and tethered hover flight tests B J

A77-34932 # Airplane/engine optimization for an operational lift/cruise V/STOL airplane S C Jensen and R J Pera (Boeing Co, Seattle, Wash) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 31-39 (AIAA 77-572)

A parametric study of optimum engine cycle/airframe match was conducted for ship-based V/STOL ASW airplanes utilizing turboshaft driven, variable pitch, lift/cruise fans. Design requirements included a short deck takeoff, climb and cruise to station, loiter at a fixed altitude, return to base, and a vertical landing. A high speed cruise Mach number and an engine out vertical landing capability were also required. Optimum designs and trades of configuration and requirements were determined through a combination of the capabilities of the Boeing Program Compiler system (PC 2.1) and the ARES data management and evaluation system (Author)

A77-34934 * # Recent research on powered-lift STOL ground effects. J P Campbell (George Washington University, Washington,

D C), J L Hassell, Jr, and J L Thomas (NASA, Langley Research Center, Subsonic-Transonic Aerodynamics Div, Hampton, Va) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 47-56 27 refs (AIAA 77-574)

Early studies of powered-lift STOL concepts indicated that a basic problem of aircraft incorporating such concepts would be a serious adverse ground effect on lift. Experience to date with actual powered-lift STOL aircraft, however, has not borne out this concern. This apparent disagreement is examined and recent research data are used to help explain some of the differences observed. Analysis indicates that most of the disagreement can be attributed to the use of wind tunnel data that were not directly applicable to the airplane because the model did not properly represent some of the design features and operating conditions of the airplane (Author)

A77-34935 * # Theoretical prediction of over-wing-blowing aerodynamics C E Lan, G Fillman (Kansas University, Lawrence, Kan), and J F Campbell (NASA, Langley Research Center, Subsonic-Transonic Aerodynamics Div, Hampton, Va) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 57-67 19 refs Grant No NsG-1302. (AIAA 77-575)

A theoretical method is developed for predicting the aerodynamic characteristics of wings with over-wing-blowing jet. The method allows the jet to stay above the wing surface as well as to wash the surface. It accounts for the wing-jet interaction due to differences between the jet and freestream dynamic pressures and Mach numbers, in addition to the jet entrainment. For the former effect, the quasi-vortex-lattice method is used to satisfy the jet and wing boundary conditions. For the latter, a new theory was developed to calculate the jet entrained flow for given jet properties. Comparison of predicted results with available data of various configurations shows reasonably good agreement. Further theoretical analysis indicates that it is aerodynamically advantageous to locate the jet exit near and ahead of the wing leading edge, and that the camber shape has significant effect on the induced drag (Author)

A77-34936 # Operational and performance criteria for STOL aircraft landings in low visibility weather conditions J A Gorham (Gorham Associates, Thousand Oaks, Calif) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 68-73 (AIAA 77-577)

The operational and performance criteria for civil CTOL passenger-carrying airplanes landing in low visibilities depend upon the characteristics of the airplane, the nature and use of the ground and airborne guidance and control systems, and the geometry and lighting of landing field. Based upon these criteria, FAA advisory circulars, airplane and equipment design characteristics, and airline operational and maintenance procedures have been formulated. The criteria for STOL airplanes are examined and differences which can influence low weather minima operation are discussed, together with their probable impact upon operations and certification (Author)

A77-34937 # Development of the circulation control wing to provide STOL potential for high performance aircraft R J Englar, L A Trobaugh, and R A Hemmerly (US Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc, 1977, p 74-84 8 refs (AIAA 77-578)

Research and development are being conducted at the David Taylor Naval Ship R and D Center to investigate the STOL capability of the Circulation Control Wing (CCW) concept on high performance aircraft. This high lift system, which employs tangential blowing over a rounded trailing edge and requires mass flows characteristic of state-of-the-art turbine engine bleed, has demonstrated the ability to

more than double the lift capability of conventional Navy and Marine aircraft. The resulting reduced takeoff and landing speeds and distances plus increased overload capability are achieved without severe compromise of wing structure, weight, or engine arrangement, and without large quantities of ducted hot gas. Based on these anticipated benefits and the results of existing experimental investigations, a program has been initiated to demonstrate the STOL capability of the CCW concept applied to a full scale A-6 flight demonstrator aircraft. The present paper will address the experimental development and optimization of the CCW system on an A-6 model and will present predicted full scale STOL performance gains for the flight demonstrator. (Author)

A77-34938 # Conceptual design studies of Navy Type A V/STOL aircraft J M Zabinsky and R W Burnham (Boeing Aerospace Co., Seattle, Wash.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 85-91. 11 refs (AIAA 77-579)

A parametric study was used to select a concept for multi-purpose Navy V/STOL. Attention is given to different configuration concepts of the V/STOL including ASW, surveillance, VOD, and marine assault. Also considered are the three fan baseline concept, variation in the number and arrangement of fans, and multimission capability. B J

A77-34939 # Impact of V/STOL operational requirements on power train design V K Rajpaul and R F Yurczyk (Boeing Aerospace Co., Seattle, Wash.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 92-96 (AIAA 77-581)

V/STOL capability for Navy missions can be achieved using mechanically interconnected lift/cruise fans. A typical airplane and power train are described. Requirements for design of the power train evolve from operational performance, integration and cost factors. The impact of these factors on the power train design is evaluated. (Author)

A77-34940 * # V/STOL shaft propulsion system analytical performance model R A Sulkoske, R N Tucker, and J E Holmes (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 97-104. Navy-NASA-sponsored research (AIAA 77-582)

Several classes of system performance simulations of V/STOL propulsion systems are presented. A digital simulation approach for a typical system (a propulsion system made up of three engines, shafts and gearbox, and remote lift fan) is given with a description of the general philosophy, solution options and model flexibility. B J

A77-34941 # V/STOL aerodynamic testing techniques at British Aircraft Corporation P G Knott (British Aircraft Corp., Ltd., Preston, Lancs., England) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 105-112. 8 refs (AIAA 77-584)

Powered lift aircraft aerodynamic testing at British Aircraft Corporation, Military Aircraft Division is focused on a 5.5 m (18') closed working section, nonreturn wind tunnel. The facility operates over a narrow free stream speed range of approximately 11 to 21 m/sec (35 to 70 ft/sec). Full-scale Mach no is therefore not maintained in the interests of drive system cost. The wide range of propulsion force coefficients required to be simulated are achieved by changing the propulsion momentum whilst the free stream momentum is kept constant. Where possible the propulsive forces are grounded (non-metric) and the airframe loading due to propulsion and free stream interaction is measured with high resolution using internal strain-gauge balances tailored to the expected load range. Propulsive stream flows are represented by cold compressed air taken

on-board through the sting support system and used either as direct feed to jet flows or as the drive air to compressed air ejectors for a better representation of air breathing propulsive systems. Whilst none of these techniques are novel, together they constitute a cost-effective testing capability, ideally suited to 'proof of concept', preliminary project design and basic research testing on powered lift aerodynamics. (Author)

A77-34942 # Management of swirling flows with application to wind-tunnel design and V/STOL testing R A Wigeland, M Ahmed, and H M Nagib (Illinois Institute of Technology, Chicago, Ill.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 113-119. Grant No DAHC04-74-G-0160 (AIAA 77-585)

The experiments utilized several swirling test flow conditions, which have different transverse distributions of angular momentum and a wide range of turbulence intensity, representing conditions present in ducts and wind tunnels, especially where V/STOL testing is performed. The effectiveness of typical flow manipulators (e.g., screens, perforated plates and honeycombs) in removing the swirl from these flows was established. Different mechanisms dominate depending on the scaling between the swirl size and the characteristic lengths of the manipulator, so a proper choice is important for obtaining optimum performance from a given manipulator. Since similar performance can be achieved by any of several manipulators, selection criteria can include other factors such as pressure drop, which is very important in wind tunnel design. (Author)

A77-34943 * # Large-scale V/STOL testing D G Koenig, T N Aiken, K Aoyagi (NASA, Ames Research Center, Moffett Field, Calif.), and M D Falarski (U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 120-133. 24 refs (AIAA 77-586)

Several facets of large-scale testing of V/STOL aircraft configurations are discussed with particular emphasis on test experience in the Ames 40- by 80-foot wind tunnel. Examples of powered-lift test programs are presented in order to illustrate tradeoffs confronting the planner of V/STOL test programs. It is indicated that large-scale V/STOL wind-tunnel testing can sometimes compete with small-scale testing in the effort required (overall test time) and program costs because of the possibility of conducting a number of different tests with a single large-scale model where several small-scale models would be required. The benefits of both high- and full-scale Reynolds numbers, more detailed configuration simulation, and number and type of onboard measurements increase rapidly with scale. Planning must be more detailed at large scale in order to balance the trade-offs between the increased costs, as number of measurements and model configuration variables increase and the benefits of larger amounts of information coming out of one test. (Author)

A77-34945 # Flight control testing of the VAK-191B R L Traskos (U S Navy, Naval Air Test Center, Patuxent River, Md.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 141-144. 6 refs (AIAA 77-588)

The U S Navy/Federal Republic of Germany Joint Flight Test Program, using the VAK-191B aircraft, was conducted to expand the base of VSTOL technology. During the flight program, an integrated test block approach was considered mandatory for the acquisition of the required data in the limited flight time available. Ground and captive rig tests were used, when applicable, to supplement data acquisition. In spite of the configuration of the captive rig, which precluded its use in the documentation of engine exhaust flow, it was considered a valuable tool in control system and engine test, and for pilot familiarization. (Author)

A77-34946 * # Fluctuating loads on the flap surfaces of an externally-blown-flap configuration J. A. Schoenster and J. C. Schroeder (NASA, Langley Research Center, Hampton, Va.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 145-151 7 refs (AIAA 77-589)

An experimental program to obtain the fluctuating loads on the surfaces of a triple-slotted externally-blown-flap powered-lift STOL configuration was conducted. A large model of a wing/flap system and a TF-34 medium bypass ratio engine was investigated. Measurements of the fluctuating pressure, static pressure, and surface temperature resulting from the jet impingement were obtained at several locations on the surfaces of the second and third flaps. Fluctuating pressure data include overall level, power-spectral density (PSD), cross-correlation coefficient, coherency, and phase angle of the cross power-spectral density. These data indicate that more than one mechanism contributes to the fluctuating pressure levels on the flaps. In the immediate area above the intersection of the engine centerline and the flap, low frequency pressures dominate the overall fluctuating pressure levels. In other areas, such as below this intersection and outboard on the flaps, the PSD curve reaches a peak value at a Strouhal number ranging from 0.22 to 0.45 (Author)

A77-34947 # Two point velocity measurements in a three dimensional wall jet. G. D. Catalano, J. B. Morton, and R. R. Humphris (Virginia, University, Charlottesville, Va.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 152-157 6 refs (AIAA 77-590)

The Upper Surface Blowing V/STOL design has been modeled as a three-dimensional wall jet. The effects of both a straight and a curved wall on the two-point space-time velocity correlations of a turbulent jet are documented. From the correlations, iso-correlation contours are constructed which allow a picture of the various flow patterns to be determined. The confining surfaces served to radically change the flow pattern of the freely expanding turbulent jet. The measurements are made with a laser Doppler velocimeter in conjunction with a phase locked-loop processor (Author)

A77-34949 * # Surface fluctuating pressure measurements on a 1/4-scale YC-14 boilerplate model R. S. Pappa (Wyle Laboratories, Inc., Hampton, Va.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 168-180 10 refs Contracts No. NAS1-12841, No. NAS1-14740 (AIAA 77-592)

A research program is conducted for the study of the fluctuating loads imposed on both upper-surface blown-flap and externally blown-flap powered-lift STOL aircraft configurations by the impingement of the jet engine exhaust flow. Attention is given to the measurement of the unsteady pressures at 30 positions in the vicinity of the jet exhaust on the surface of a NASA 1/4-scale YC-14 boilerplate wing and fuselage section G. R.

A77-34950 # USB environment assessment based on YC-14 flight test measurements M. B. Sussman, J. B. Reed, J. V. O'Keefe, and W. M. Eldridge (Boeing Co., Seattle, Wash.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 181-187 (AIAA 77-593)

Static pressures, surface temperatures, surface fluctuating pressures and acceleration levels were measured in the environment of a full-scale upper surface blowing (USB) propulsive-lift aircraft. The measurements were accomplished in conjunction with the developmental flight test of the USAF YC-14 Advanced Medium STOL Transport for both low speed and cruise conditions. Results from preliminary analysis of the data generally show reasonable agreement with predicted levels based on wind-tunnel model and full-scale static ground test data. In fact, the flight environment was more moderate than predictions. Additional detailed analysis is recommended to confirm the preliminary evaluations (Author)

A77-34951 * # Tenth-scale powered model test of a tilt-nacelle V/STOL airplane M. E. Omar (Boeing Aerospace Co., Seattle, Wash.) and B. A. Lampkin (NASA, Ames Research Center, Moffett Field, Calif.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 188-193 (AIAA 77-594)

Wind tunnel and ground static tests of a tenth scale powered model of a lift/cruise fan airplane have been conducted to define its low speed performances and handling qualities. The model was powered by three 5.5-in diameter turbopowered simulators, one located in the forebody while the remaining two were installed in tilting nacelles mounted on the aft body. Results are presented for static hover tests in ground effects with the model configured for VTOL operations and at forward speeds with the model configured for loiter, short takeoff, and VTOL operations (Author)

A77-34953 * # Validation of AV-8B V/STOL characteristics by full scale static and wind tunnel tests E. G. Hollingsworth (McDonnell Aircraft Co., St. Louis, Mo.), T. N. Aiken (NASA, Ames Research Center, Moffett Field, Calif.), and J. Raggett (US Naval Air Systems Command, Washington, D.C.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 201-209 (AIAA 77-597)

The background which led to the requirement for the full scale powered wind tunnel tests of an AV-8B model, and the formulation of specific objectives for the test, are outlined. The detailed planning, analysis, and coordination with NASA, NAVAIR, and other industry participants is described. The modification of an AV-8A Harrier into an AV-8B configuration suitable for full scale testing at Ames is described. In addition, instrumentation and data systems are explained. Operations during the 40 ft x 80 ft wind tunnel testing and the resulting propulsion, aerodynamic, performance, stability and control data are presented and suggestions offered for future V/STOL testing (Author)

A77-34954 # Experimental investigations of control-display requirements for VTOL instrument transitions J. V. Lebacqz and E. W. Aiken (Calspan Corp., Buffalo, N.Y.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers

New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 210-217 11 refs Contracts No. N00019-73-C-0504, No. N62269-76-C-0370 (AIAA 77-599)

Two consecutive flight research programs using the X-22A variable stability V/STOL aircraft have investigated guidance, display, and control requirements for VTOL aircraft operating in the terminal area under instrument conditions. The first experiment was directed at defining the interplay between generic levels of control system augmentation and display presentation information. The second, due for completion in September 1977, is a more specialized study of the control requirements for a specific VTOL (the McDonnell-Douglas AV-8B), and includes a ground simulation experiment plus in-flight verification. This paper describes both experiments and discusses the results that have been obtained to date (Author)

A77-34955 # Advanced integrated display system (AIDS) for V/STOL aircraft L. O. Osterman (General Electric Co., Aircraft Equipment Div., Utica, N.Y.) and W. G. Mulley (U.S. Navy, Naval Air Development Center, Johnsville, Pa.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 218-228 (AIAA 77-600)

AIDS will provide an improved man-machine interface for future Navy aircraft. The system design program now underway will bring together technology developments in displays, controls, display processors, data buses, and data processing with developing pilot/aircrew information requirements to yield an operationally superior display and control system for the 1980s. This paper emphasizes AIDS applications to the Navy's Type A V/STOLs (Author)

A77-34956 * # Design and evaluation of an integrated flight-control system concept for manual IFR VTOL operations. V K Merrick (NASA, Ames Research Center, Flight Dynamics and Controls Branch, Moffett Field, Calif) and R M Gerdes (NASA, Ames Research Center, Flight Operations Branch, Moffett Field, Calif) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 229-237 13 refs. (AIAA 77-601)

An integrated flight controller, display, and power management system design, suitable for all-weather VTOL flight operations onto small ships, is described. The flight controller uncouples the aircraft's translational and attitude motions, which are then commanded by the pilot, through separate controls. A head-up display provides situation and flight director information sufficient to permit zero-zero landings. The system was applied to a VTOL transport model and simulated on moving base simulators at Ames Research Center. Presented herein are results concerning the aircraft's general handling qualities and, in particular, its handling qualities during IFR landings onto a moving ship. (Author)

A77-34958 * # Spiral approach navigation concepts for VTOL aircraft using a microwave landing system. L A McGee (NASA, Ames Research Center, Aircraft Guidance and Navigation Branch, Moffett Field, Calif) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 248-256 (AIAA 77-603)

Spiral approaches adjacent to the active runways of CTOL airports have been proposed as a means of effectively interfacing CTOL and VTOL landing operations. Assuming an airport equipped with a Microwave Landing System (MLS), a VTOL aircraft following a spiral approach path might, depending on the specific trajectory, pass alternatively in and out of the linear coverage of the MLS and thereby suffer degraded navigation performance. The objective of this study was to employ essentially state-of-the-art aided inertial navigation concepts to explore the expected navigation performance operating in the environment just described. Results show that aided inertial concepts utilizing simple body-mounted inertia systems may be adequate for an instrument landing if the MLS azimuth and Distance Measuring Equipment (DME) signal coverages extend to within a few feet of the ground. (Author)

A77-34959 # The AV-8B wing - Aerodynamic concept and design. T R Lacey (McDonnell Aircraft Co., St. Louis, Mo) and K Miller (US Naval Air Systems Command, Washington, D C) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 257-264 (AIAA 77-607)

The payload-radius capability of the AV-8A V/STOL Aircraft is essentially doubled for a given STOL length by the design improvements incorporated in the AV-8B Aircraft. Much of this increased capability is directly attributable to the new wing design. This paper discusses the aerodynamic concepts employed and the design tradeoffs considered in arriving at the final configuration. Both semi-jetborne and fully wing-borne design considerations are treated. The wind tunnel test program, utilizing both powered and flow-through scale models plus a full scale powered model, is reviewed with comparative AV-8A and AV-8B data provided to substantiate the critical performance improvements. (Author)

A77-34960 * # Flight evaluation of flight-path control required for the approach and landing of STOL aircraft. J A Franklin (NASA, Ames Research Center, Flight Dynamics and Controls Branch, Moffett Field, Calif) and R C Innis (NASA, Ames Research Center, Flight Operations Branch, Moffett Field, Calif) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 265-275 16 refs (AIAA 77-609)

Flight experiments have been conducted as part of a program to assess requirements for flight path control for glide-slope tracking

and for control of the flare and landing for STOL aircraft. The Augmentor Wing Research Aircraft was used to perform landing approaches on a 7.5 deg glide slope to landings on a 30 x 518 m STOL runway. The flight results identified flight-path overshoot and vertical velocity damping to be the dominant aircraft response characteristics that affect glide-slope tracking. The one prominent contribution to control of flare using pitch attitude was the short-term path response. (Author)

A77-34961 * # An in-flight simulation of VTOL hover control concepts. L D Corliss (NASA, Ames Research Center, U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif), R K Greif, and R M Gerdes (NASA, Ames Research Center, Moffett Field, Calif) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 276-281 5 refs (AIAA 77-610)

Results of several parametric ground-based simulations covering a variety of VTOL in-hover control concepts are reviewed. The systems considered are angular acceleration, rate, and attitude control, as well as translational rate control. Since many cues are severely restricted by ground-based simulation (e.g., motion, peripheral vision, and environment), some form of in-flight validation of these results is desired. Such a study has been undertaken utilizing the NASA Ames X-14B VTOL aircraft. This in-flight simulator has been configured with a fly-by-wire capability in the hover mode through an analog/digital variable stability system. This system permits the implementation of either response-feedback or model-following type of control. A comparison of flight- and ground-based data is shown for the attitude control system with the X-14B being flown in both a tethered hover and a free-flight hover. (Author)

A77-34962 * # Analysis of control concepts for gas and shaft-coupled V/STOL aircraft lift fan systems. J F Sellers, C E Hart, and J R Mihaloew (NASA, Lewis Research Center, Cleveland, Ohio) In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 282-292 16 refs (AIAA 77-611)

V/STOL aircraft rely on their propulsion systems to provide lift and attitude control moments during hover and low-speed flight. For lift-fan powered V/STOL aircraft, two unconventional propulsion system types have been proposed. The first type uses fans connected by hot gas ducting, and the second type uses fans connected by cross shafting. This paper presents results of an analytical study which identifies the basic steady-state and dynamic characteristics for each type of system. For the gas-coupled system, the control concepts analyzed were variable-area fan turbines and throttling valves in the ducting. For the shaft-coupled system, the control concepts analyzed were variable-pitch fans and variable fan inlet guide vanes. All of these concepts are shown to be capable of meeting V/STOL aircraft control moment and transient response requirements when appropriate propulsion controls are used. Each type of system has unique problem areas which require an integrated approach to aircraft/propulsion control design. (Author)

A77-34963 # Integration and simulated flight testing of a geared fan V/STOL airplane. L O Billig and G W N Lampard. In V/STOL Conference, Palo Alto, Calif, June 6-8, 1977, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 293-298 (AIAA 77-612)

This paper presents an integration and system-level testing program for a prototype V/STOL airplane. The program was developed for the NASA Research Technology Airplane (RTA) and was modified for the Navy Type A V/STOL. This configuration has two (or four) podded engines driving three variable pitch fans through a gear and shaft drive train. The conservative approach uses a large-scale ground mounted test rig. A complete ship's set of propulsion hardware is installed on a steel framework that is mounted on a six-component balance. A boiler plate crew station, interfaces with the test rig and an aerodynamic model (simulation) of

the airplane to permit real-time man-in-the-loop testing of flight and propulsion controls. The propulsion system and flight controls will be qualified for powered-lift flight upon completion of this test program. (Author)

A77-34964 # A basic study of the VTOL ground effect problem for planar flow. D. R. Kotansky and W. W. Bower (McDonnell Douglas Research Laboratories, St. Louis, Mo.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 299-307. 6 refs. Research sponsored by the McDonnell Douglas Independent Research and Development Program, Contract No. N00014-76-C-0494. (AIAA 77-614)

The interaction of lift jets and the ground is an important consideration for VTOL aircraft design. As a first step toward prediction of this phenomenon, a combined theoretical and experimental investigation of planar turbulent jet impingement flowfields has been undertaken. Unvectored jets in close ground effect have been modeled using the incompressible Reynolds equations with a one-equation turbulence model. Distributions of the flow properties are computed as functions of Reynolds number based on jet exit properties, length scales, and jet exit height above ground. Computed flowfield properties are presented, and comparisons are made with experimental measurements. (Author)

A77-34965 # Reingestion and footprint characteristics of the VAK 191B. R. A. Weinraub (US Naval Air Systems Command, Washington, D.C.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 308-313. (AIAA 77-617)

During 1974 and 1975, the US Navy and the Federal Republic of Germany jointly flight tested the VAK 191B V/STOL aircraft. One of the primary objectives of this test program was to obtain full scale reingestion and footprint data which could be directly compared with existing model scale data. An evaluation of the flight test data has demonstrated that the scaled-up model test results accurately predicted the reingestion and footprint characteristics of this aircraft. This paper summarizes the results of an investigation of the reingestion and footprint characteristics of the VAK 191B. (Author)

A77-34966 # Infrared flow visualization for VTOL applications. J. W. Flaig (US Naval Air Systems Command, Washington, D.C.) In V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 314-321. 7 refs. (AIAA 77-618)

Tests utilizing an infrared imaging system have been conducted by the US Navy to examine the engine-exhaust-induced flow of VTOL aircraft. Results indicate that a continuous visual record of the flow patterns and interactions between engine exhausts can be obtained with this system. This visual record provides simultaneous generalized information for a large area of interest, as such it complements the data gathered at discrete points by standard thermocouples and pressure transducers. (Author)

A77-34967 # The application of QCSEE technology to V/STOL. W. S. Willis and D. C. Genever-Watling (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio.) *American Institute of Aeronautics and Astronautics and NASA Ames Research Center, V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, AIAA Paper 77-583* 8 p.

While at this point in time no particular propulsion system configuration has been chosen for the V/STOL Type A, many combinations of number of fans, gas generators, and methods of power interconnection have been investigated. Low pressure systems under consideration include variable pitch and variable inlet guide vanes for thrust modulation, geared and direct turbine drive, and shaft and gas power transfer systems. Several of these features are

being studied in the Quiet, Clean, Short-Haul, Experimental Engine (QCSEE) program, which is developing the technology needed for future short-haul passenger aircraft. Test status and key characteristics of QCSEE engines and their components are discussed in detail. M. L.

A77-34969 * # The transonic multi-foil Augmentor-Wing. J. E. Farbridge (de Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada) and R. C. Smith (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics and NASA Ames Research Center, V/STOL Conference, Palo Alto, Calif., June 6-8, 1977, AIAA Paper 77-606* 10 p. Research supported by the Department of National Defence of Canada and NASA.

The paper describes the development of a transonic blown multi-foil Augmentor-Wing airfoil section that has a thickness/chord (t/c) value of 0.18. In comparison with an unblown single-foil supercritical section of the same overall t/c the new multi-foil section is characterized by an increased drag rise Mach number, increased buffet boundaries, and a reduction in 'effective' drag due to blowing. Potential advantages of the Augmentor-Wing are considered and the testing of three high-speed models in a transonic pressurized wind tunnel (possessing a two-dimensional transonic insert) is discussed. The data indicate that a very thick wing is feasible since separations toward the rear of the main foil can be controlled both by shroud location and augmentor blowing. M. L.

A77-35008 Dynamic-stress-data management for aeromechanical testing of turbomachinery. W. J. Rakowski (ARO, Inc., Engine Test Facility, Arnold Air Force Station, Tenn.) *(Society for Experimental Stress Analysis, Spring Meeting, Silver Spring, Md., May 9-14, 1976) Experimental Mechanics*, vol. 17, June 1977, p. 207-212.

The present discussion is centered on the evolution of on-line data-monitoring and posttest data-processing/analysis techniques used to support dynamic strain-gage test programs. The data-management philosophy and techniques developed for the dynamic strain-gage data acquired during these programs are treated in detail. V. P.

A77-35021 # V/STOL and the naval planner's dilemma. D. C. Hazen (Princeton University, Princeton, N.J.) *Astronautics and Aeronautics*, vol. 15, June 1977, p. 20-29.

It is seen that if the Navy, due to the extremely high cost of Nimitz-class carriers, starts thinking in terms of more but smaller carriers, V/STOL aircraft would finally find a long-sought application. In the present paper, the problems confronting US naval planners are examined in an effort to gain insight into the Navy's quandary of how to maintain (and augment) the flexibility and power of the US fleet. It is shown that one large ship can be built and manned more cheaply than two ships half its size, and that to lower the fleet's air power would be 'tantamount to a national death wish'. The need to carefully analyze alternative methods of augmenting the fleet's air power is indicated. As a result, the US fleet of the 1990s would be a blend of systems and abilities that in combination attempt to meet the requirements. Whether or not V/STOL aircraft will constitute an element of this blend will depend on the result of development efforts over the next twenty years. V. P.

A77-35022 # A naval VATOL RPV in testing. W. H. Eilertson (US Naval Material Command, David W. Taylor Ship Research and Development Center, Bethesda, Md.) *Astronautics and Aeronautics*, vol. 15, June 1977, p. 30-37. 6 refs.

Progress in light-weight electronics has caused the Navy to assess the advantages that might accrue from the use of remotely piloted vehicles (RPVs). Analyses indicate that RPVs can be 60% lighter and cost only a third as much as comparable manned aircraft intended for similar missions. RPVs would improve the Navy's air support and favorably complement manned aircraft. They could be designed to fly long-endurance missions (free of constraints imposed on manned aircraft) and to be highly maneuverable against heavily defended

targets. They would not, however, replace manned aircraft in support missions requiring high reliability in engaging targets posing an immediate threat to the fleet. In the present paper, tests are described which demonstrated the advantages of vertical-attitude takeoff and landing (VATOL) over other approaches to launching and recovering RPVs. V P

A77-35032 Future propulsion plants. II (Triebwerke der Zukunft II) W Heilmann (Motoren- und Turbinen-Union München GmbH, Munich, West Germany) *Flug Revue/Flugwelt International*, June 1977, p 100, 102, 104, 105. In German

New trends in engine and engine parts design in response to requirements dictated by environmental protection, long service life, and reduced operating costs are discussed. Superplastic shaping of turbine blades and turbine disks for elevated temperature service is described. Abatement of noise and emission of pollutants, engine geometry for noise reduction, and low-emissions injection systems are dealt with. Optimization of turbine entrance temperature, cooling methods, and loading for longer service life are discussed. A special section deals with new trends in propulsion systems for supersonic transports and military aircraft. R D V

A77-35071 # Aggregate flow model for evaluating ATC planning strategies. P J Wong, G J Couluris (Stanford Research Institute, Menlo Park, Calif.), and D K Schmidt (Purdue University, West Lafayette, Ind.) *Journal of Aircraft*, vol 14, June 1977, p 527-532. 7 refs. FAA-supported research

An aggregate traffic flow model is developed and used to evaluate the potential benefits of automated, facility-level, on-line air traffic flow control. Most present air traffic models simulate, in varying levels of detail, the movement of individual aircraft, which results in considerable computational requirements. However, the model described here essentially monitors and dynamically adjusts traffic flow rates and traffic densities on the routes in the ATC network. The route flow adjustments are based on controller workload criteria, with the intent of eliminating traffic surges and the associated periods of excessive workload. The model is used to evaluate two flow control strategies with respect to aircraft delay, controller workload, and staffing considerations at Los Angeles Air Route Traffic Control Center. (Author)

A77-35073 # Measurements on a delta wing in unsteady flow. A G Parker (Texas A & M University, College Station, Tex.) *Journal of Aircraft*, vol 14, June 1977, p 547-552. 30 refs. Contract No. N00014-75-C-0255

Low-speed wind-tunnel tests were undertaken to determine the vortex location, vortex burst location, and upper surface pressure distribution on a delta wing (aspect ratio = 2) in an oscillatory airstream. In steady flow an axisymmetric 'tulip'-type burst was observed at all angles of attack, whereas in unsteady flow the vortex core gradually dissipated into turbulence for increasing angles of attack but formed a 'helical'-type burst for decreasing angles. The pressure distributions showed that in unsteady flow there were considerable phase lags in the suction peaks associated with the vortices but virtually no lags elsewhere on the wing. (Author)

A77-35078 * # An implicit shock-fitting scheme for unsteady transonic flow computations. N J Yu, A R. Seebass (Arizona, University, Tucson, Ariz.), and W F. Ballhaus (Arizona, University, Tucson, Ariz., U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) In *Computational Fluid Dynamics Conference*, 3rd, Albuquerque, N Mex., June 27, 28, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 13-26. 26 refs. Contract No. NSG-2112, No. AF-AFOSR-76-2954. (AIAA 77-633)

The alternating-direction implicit scheme developed by NASA Ames for unsteady transonic flows has been modified to include a shock-fitting algorithm as well as an analytically stretched coordinate system. The shock-fitting procedure treats shock waves as discontinuities normal to the free stream. Improvements in shock position

and the unsteady pressure distributions are obtained by this modification. The various types of shock motion observed experimentally by Tijdeman are well simulated in calculations using the modified computational scheme. The method of detecting shock wave formation and the procedure for fitting a moving shock wave are illustrated. Results for a pulsating parabolic arc airfoil and for an NACA 64A006 airfoil with oscillating quarter-chord flap are presented and discussed. (Author)

A77-35079 # Implicit approximate-factorization schemes for the efficient solution of steady transonic flow problems. W F. Ballhaus (U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.), A Jameson (New York University, New York, N Y), and J Albert. In *Computational Fluid Dynamics Conference*, 3rd, Albuquerque, N Mex., June 27, 28, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 27-34. 22 refs. (AIAA 77-634)

Implicit approximate-factorization algorithms (AF) are developed for the solution of steady-state transonic flow problems. The performance of the AF solution method is evaluated relative to that of the standard solution method for transonic flow problems, successive line over-relaxation (SLOR). Both methods are applied to the solution of the nonlinear, two-dimensional transonic small-disturbance equation for flows about representative transonic airfoils. Results indicate that the AF method requires substantially less computer time than SLOR to solve the nonlinear finite-difference matrix equation for the flow field. This increase in computational efficiency is achieved with virtually no increase in computer storage or coding complexity. (Author)

A77-35085 # Recent improvements in surface singularity methods for the flow field analysis about two-dimensional airfoils. D R Bristow (McDonnell Aircraft Co., St Louis, Mo.) In *Computational Fluid Dynamics Conference*, 3rd, Albuquerque, N Mex., June 27, 28, 1977, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p 95-105. 18 refs. (AIAA 77-641)

The combined source-doublet distribution corresponding to the classical Green's identity has been incorporated in a numerical method for predicting the properties of incompressible potential flow past one or more arbitrary lifting airfoils. The method uses piecewise linear singularity distributions on geometric panels with a higher order surface curvature correction. Sample numerical solutions are presented to demonstrate the advantages of the method with respect to prediction accuracy, numerical stability, computational expense, and applicability to inverse problems. Explanations for these advantages are offered based on classical surface singularity theoretical relationships and numerical analysis. (Author)

A77-35098 # Calculation of swirling flow in turbomachine cascades on the basis of two-dimensional theory (Raschet zakrutki potoka v lopatochnykh apparatakh turbomashin po dvumernoi teorii). M I Zhukovskii (Leningradskii Metallicheski Zavod, Leningrad, USSR) *Teploenergetika*, Apr 1977, p 70-72. 7 refs. In Russian

Profiling of axial-flow turbine blades is conventionally based on the calculation of cascade flows on the basis of a simplified radial equilibrium equation, using various swirl laws. In the present paper, a new formulation is proposed for the inverse problem of blade profiling. It is based on setting the velocity-gradient moment at the lines of intersection of the blade's skeletal surface with planes running through the axis of rotation. The method makes it possible to control effectively the nature of energy conversion. V P

A77-35150 Aviation turbine fuels from shale and coal oils. H Shaw, C D Kalfadelis, and C E Jahnnig (Exxon Research and Engineering Co., Government Research Laboratories, Linden, N J.) In *Energy and the environment, Proceedings of the Third National Conference*, Oxford, Ohio, September 29-October 1, 1975. Dayton, Ohio, American Institute of Chemical Engineers, 1975, p 40-48. 11 refs. Contract No. F33615-74-C-2036

A three phase program is described. The first recently completed initial phase determined which domestic sources of synthetic crudes (shale, coal, etc.) can be used as refinery feedstocks to produce aviation turbine fuels. The second phase is intended to experimentally confirm the suitability of synthetic crudes produced from oil shale and coal as sources for a wide-cut and narrow-cut jet fuel. The final phase will assess the engineering and economic factors for producing aviation turbine fuels from synthetic sources. B J

A77-35155 The production of shale oil crude and its refining into military operational fuels. H. Bartick (Applied Systems Corp., Arlington, Va.) In: Energy and the environment, Proceedings of the Third National Conference, Oxford, Ohio, September 29-October 1, 1975. Dayton, Ohio, American Institute of Chemical Engineers, 1975, p. 93-99. Contract No. N00014-75-C-0055.

The production of 5,765 bbl of various military fuels (JP-4, JP-5/Jet-A, DFM/DF-2, gasoline, Heavy Fuel Oil) from 10,000 bbl of crude shale oil was accomplished in a commercial small-scale refinery having a capacity of about 9,000 BPSD. The 10,000 bbl of crude shale oil was produced by the Paraho process using the shale mined from the Naval Oil Shale Reserve located at Anvil Points, Colorado. The various fuels produced met a majority of the military, federal, and commercial specifications' requirements. However, these fuels tended to exhibit storage and thermal instabilities. In addition, the fuels contained a high wax content, high particulate matter, and high gum content. It is believed that a higher pressure in the hydrogenation stage (about 1500-3,000 psi), along with clay treatment of the final products, would reduce or eliminate some or most of these problem areas. (Author)

A77-35246 # Flight decks for future civil transport aircraft. L. F. Bateman (British Aircraft Corp., Ltd., Weybridge, Surrey, England). *Journal of Navigation*, vol. 30, May 1977, p. 207-219.

The design of flight decks for British civil transport aircraft scheduled to enter service in the 1980s is described. The change from the conventional electromechanical instruments to electronic displays should offer a reduction in crew workload, improved flight safety, reduced cost, and greater flexibility. The change will also help to meet the increasing difficulty of accommodating the instruments and controls necessary for safe and efficient operation. Several display patterns are illustrated and the advantages of the new systems are summarized. M. L.

A77-35248 # Precision navigation updating by means of digital area correlation. A. Hessel and W. Eckl (Messerschmitt-Bolkow-Blohm GmbH, Munich, West Germany). *Journal of Navigation*, vol. 30, May 1977, p. 296-306. 9 refs. Research sponsored by the Bundesministerium der Verteidigung.

An automatic navigation updating system would require that information pertaining to the topography over which the plane is flying be stored as a 'reference picture' and be available for comparison with an 'actual picture' obtained by the aircraft's sensor equipment. This area correlation can be performed in two ways, the interrupted continuous mode (ICM) and the uninterrupted continuous mode (UCM). In the ICM the correlation procedure is restricted to selected areas where unambiguous characteristics will guarantee a good correlation peak. For the UCM a complete reference picture between take-off and point of destination must be available. In comparison with ICM, the width of the reference band can be much smaller, although the memory storage necessary for the reference will be much greater. Factors such as altitudinal or seasonal variations that could complicate area correlation are discussed. M. L.

A77-35601 # Flow past the lower surface of delta wings in off-design mode at Mach numbers less than the design Mach number. (Obtekanie nizhnego poverkhnosti V-obraznykh kryl'ev na nerazchetnykh rezhimakh pri chislakh Makha, men'shikh raschetnogo). In: P. Gun'ko and I. I. Mazhul' (Akademiya Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). *Akademiya*

Nauk SSSR, Sibirskoe Otdelenie, Izvestiya, Seriya Tekhnicheskikh Nauk, Feb. 1977, p. 8-12. 8 refs. In Russian.

Tests were conducted in a supersonic wind tunnel to investigate the flow past the lower surface of a delta wing at Mach numbers of the incoming flow (1.75, 2.25, 3, and 4) less than the design Mach number, with consideration of a shock wave below the plane of the leading edges of the wing. It is found that flow near most of the lower surface remains practically uniform, while the momentum characteristics depend on the degree of deviation from the design mode and the geometrical characteristics of the wing. B. J.

A77-35692 # Face hardening as a means of improving the fatigue strength of aircraft gas-turbine compressor disks (Primenenie metodov poverkhnostnogo plasticheskogo deformirovaniya dlia povysheniya ustalostnoi prochnosti diskov kompressorov aviatsionnykh GTD). B. M. Agishev, A. A. Elantsev, and N. V. Moiseev. *Problemy Prochnosti*, Mar. 1977, p. 114-116. In Russian.

Crack nucleation and propagation patterns characteristic of first-stage disks made of 30 KhGSA and EI961Sh steel and of OKhN3M-steel disks of the two last stages of low-pressure compressors are examined and are attributed to fatigue. It is shown how this delinquency could be eliminated by rolling and shot peening. V. P.

A77-35695 # Analysis of the accuracy of operation of the ranging channel of a Shoran system (Otsenka tochnosti raboty dal'nomernogo kanala sistemy RSBN). A. V. Lipin (Akademiya Grazhdanskoi Aviatcii, USSR). *Geodeziya i Aerofotogrammetriya*, no. 6, 1976, p. 31-35. In Russian.

The paper considers a method for estimating the accuracy of the ranging channel of a short range air navigation system, based on the possibility of the synchronized determination of azimuth and range from the normal profiles of two radio beacons, with subsequent transition to a central profile passing through these beacons. Solutions are obtained on a Gaussian plane and on a sphere of normals. B. J.

A77-35844 Performance of a square law pseudonoise ranging time-of-arrival estimator. A. Weinberg (Mitre Corp., McLean, Va.). *IEEE Transactions on Aerospace and Electronic Systems*, vol. AES-13, May 1977, p. 290-301. 8 refs. U.S. Department of Transportation Contract No. FA70WA-2448.

The performance of a square law time-of-arrival (TOA) estimator that has been proposed for use in ASTRO-DABS, part of a possible satellite-based fourth generation air traffic control system is considered. The transmitted message consists of a pulse amplitude modulated (PAM) ranging sequence that, due to transmitter characteristics, is corrupted by an unknown frequency offset. The optimum TOA estimator, for the case of no frequency uncertainty, is first presented, together with a lower bound on the variance of the estimate generated. This is followed by the consideration of a suboptimum TOA estimator for which a high signal-to-noise ratio (SNR) performance analysis is carried out; here, the effects of frequency uncertainty are included. Next, the zero-crossing properties of the derivative of the (suboptimum) estimation statistic are presented and the results used to derive an upper bound to the TOA estimate variance that is valid for all SNR values. This latter result is significant because it displays the system threshold effect and complements performance lower bounds that may be derived via other methods. In addition, the method presented here may be applied to other optimum and suboptimum systems where a discrete set of parameters is to be estimated. (Author)

A77-35913 Two body fixes by calculator. M. F. A'Hearn and G. S. Rossano (Maryland, University, College Park, Md.). *Navigation*, vol. 24, Spring 1977, p. 59-66.

We present an approach to the solution of the two body fix which utilizes all of the computing capability of a pocket calculator (non-programmable). The method results in substantial time savings.

over the normal approach, either by calculator or by tables, and requires no plotting, no assumed positions, and only a very rudimentary estimate of the navigator's position, the last only for correcting for motion between the times of the two sights (Author)

A77-35915 A multi-DME/inertial system for aircraft positioning. R W Latham and P T Richards (Grumman Aerospace Corp., Calverton, N Y) *Navigation*, vol 24, Spring 1977, p 72-83 6 refs

A test system was assembled to explore the concept of aircraft positioning by combining inertial navigation system data with DME range measurements acquired sequentially from multiple stations. Post-flight processing software was developed using computer simulated data, with many of the predicted performance parameters later confirmed by flight tests. The results indicate that horizontal positioning accuracies of ten to fifteen meters (CEP) and rms velocity errors better than 0.1 meter per second are achievable with the system (Author)

A77-35918 * Analytical display design for flight tasks conducted under instrument meteorological conditions. R. A Hess (NASA, Ames Research Center, Aircraft Guidance and Navigation Branch, Moffett Field, Calif.) *IEEE Transactions on Systems, Man, and Cybernetics*, vol SMC-7, June 1977, p 453-462 19 refs

A relatively straightforward, nearly algorithmic procedure for deriving model-based pilot-centered display requirements is presented. A pilot model based on modern control theory serves as the backbone of the design methodology, which is specifically directed toward the synthesis of head-down, electronic cockpit display formats. Some novel applications of the optimal pilot model are discussed, including the generation of vehicle-handling-qualities levels via numerical pilot-opinion ratings. An analytical design example is offered which aids in the definition of a format for the electronic display to be used in a UH-1H helicopter in a landing-approach task involving longitudinal and lateral degrees of freedom. It is proposed that the design procedure offers a systematic means for generating candidate display formats and flight-director laws for simulator evaluation (Author)

A77-35925 * Identification of state variables and dynamic inflow from rotor model dynamic tests. D Banerjee, S T Crews, K. H. Hohenemser, and S K Yin (Washington University, St. Louis, Mo.) *American Helicopter Society, Journal*, vol 22, Apr 1977, p 28-36 14 refs Contract No NAS2-7613

The paper describes methods for extracting unknown state variables and parameters from dynamic rotor model tests given transient cyclic pitch stirring inputs, blade root flap-bending measurements, and the form of the dynamic rotor equations, including a rotor dynamic inflow description, when none of the physical parameters are known. A simplified version of the maximum likelihood method seems best suited for this purpose. The measurement equation error covariance matrix is assumed constant during each iteration, but updated for the subsequent iteration. A detailed analysis of the suitability of the derived techniques for studying various rotor dynamic inflow effects is provided. M L

A77-35929 # Synthesis of control systems with specified transfer functions (Sintez sistem upravleniya s zadannymi peredatochnymi funktsiyami). E M Smagina *Avtomatika i Telemekhanika*, Apr 1977, p 13-16 6 refs In Russian

The problem of synthesizing a linear controller, ensuring a specified distribution of the transfer function's zeros and poles is solved for a multivariable steady dynamic system with a scalar output. The solution is obtained by reducing the initial system to a special canonical form. As an example, this approach is applied to the matrix equation of aircraft motion in the pitching plane. V P

A77-36122 Response of a subsonic nozzle to acoustic and entropy disturbances. M S Bohn (California Institute of Technology, Pasadena, Calif.) *Journal of Sound and Vibration*, vol 52, May 22, 1977, p 283-297 7 refs

The paper calculates the one-dimensional response of a subsonic nozzle flow to small pressure and entropy disturbances, with application to the core noise of a turbojet engine. The response is expressed in terms of transmitted sound waves and reflected sound waves for three independent disturbances: a downstream-propagating sound wave impinging on the nozzle inlet, an upstream-propagating wave impinging on the nozzle exit, and an entropy wave convecting through the nozzle. B J

A77-36155 An experimental and theoretical investigation of the structure of a trailing vortex wake. R G Sampson (Royal Military College of Science, Shrivenham, Wilts., England) *Aeronautical Quarterly*, vol 28, Feb 1977, p 39-50 24 refs

An improved technique for the use of a five-hole yaw probe has been used in determining velocity, vorticity and pressure distributions over a transverse plane five chords downstream of a lifting wing. A well-defined tip vortex is shown to exist, together with a vortex sheet which contains a significant proportion of the total vorticity. The vorticity distribution is compared with that predicted by the calculation of vortex sheet roll-up using a two-dimensional array of line vortices. Good agreement is obtained, and the validity of using time steps large enough to inhibit the chaotic motion found in some calculations of this type is demonstrated. The structure of the tip vortex is found to be well described by the turbulent vortex model of Hoffman and Joubert (Author)

A77-36156 An investigation of an inclined jet in a crosswind. P Taylor (Southampton University, Southampton, England) *Aeronautical Quarterly*, vol 28, Feb 1977, p 51-58 6 refs

Wind-tunnel experiments were conducted to determine the interference characteristics of an inclined turbulent jet exhausting from a flat plate into a turbulent subsonic-crosswind. The jet was not yawed with respect to the undisturbed free stream. The suction force (lift loss), the jet penetration into the crosswind, the jet deflection and the rate of total pressure decay along the jet center line were all reduced by an increase in the inclination of the jet. The center of pressure moved downstream. These results were attributed to a decrease in the entrainment rate of the jet as the inclination increased in a downstream direction (Author)

A77-36157 A new series of aerofoil sections suitable for aircraft propellers. A J Bocci (Aircraft Research Association, Ltd., Bedford, Beds., England) *Aeronautical Quarterly*, vol 28, Feb 1977, p 59-73 6 refs

A series of advanced aerofoil sections suitable for aircraft propellers has been developed. The sections combine advanced supercritical flow characteristics with good low-speed performance and are also directly applicable to other rotating aerodynamic machinery, such as low-solidity ducted fans, windmills, etc. The work has focused initially on propeller sections of around 6 per cent thickness/chord ratio, typical of the fundamental blade station where peak loading is usually carried (0.7 x radius). The complete section family covers a wide range of thickness/chord ratios, from 3 per cent to over 20 per cent. The profiles are defined by mathematical formulae and distort with thickness to achieve a shape having optimum performance characteristics at the flow conditions expected for that thickness. A subset of the family is defined for higher Mach number penetration, up to near sonic values (Author)

A77-36158 * # Optimization of active control systems to suppress flutter and minimize turbulence response. C S Rudisill (Clemson University, Clemson, S C.) *AIAA Journal*, vol 15, June 1977, p 779-785 12 refs Grant No NSG-1125

A method for optimizing an active control system which will suppress flutter and minimize the response of a lifting surface to atmospheric turbulence is presented. A mathematical search method is developed which will find a control law which will cause an active control system to flutter at a specified freestream velocity, air density, and Mach number. With the flutter velocity of the system held constant, the control law is then modified in such a way that the peak output power spectral density function of the angular

response of a lifting surface (as a result of atmospheric turbulence) is minimized for a specified flight velocity which is less than the flutter velocity. The von Karman generalized power spectrum for the transverse components of turbulence is used in an example problem to increase the flutter velocity and minimize the turbulence response of a simplified delta-wing model which has leading and trailing edge control surfaces (Author)

A77-36160 # Oscillating delta wings with attached shock waves D D Liu (Northrop Corp., Hawthorne, Calif.) and W H Hui (Waterloo, University, Waterloo, Ontario, Canada) *AIAA Journal*, vol 15, June 1977, p 804-812 26 refs Research supported by the Ministry of Defence (Procurement Executive) and National Research Council of Canada

An unsteady flow theory is presented for studying the flowfield in the compression side of an oscillating flat delta wing with attached shock waves Regular perturbation methods are used to analyze the in-phase and out-of-phase flow components for small amplitudes and reduced frequencies In particular, the out-of-phase flow is found to be 'quasiconical,' thus a pressure formulation can be realized In the outboard region, where the crossflow is supersonic, exact solutions are found representing parallel surfaces of isobars In the central region where the crossflow is subsonic, the problem is reduced to that of an ordinary-differential equation by a spanwise integration technique Closed-form solutions are obtained for all cases Numerical examples are presented to exhibit the dependence of the damping derivatives on several flow and geometrical parameters Neutral damping boundaries are also given It is found that the damping derivatives are generally less sensitive to the sweepback-angle and the freestream Mach number variations than to the mean-incidence variations, except near the shock detachment Critical assessment, improvement schemes and future extensions were also discussed

(Author)

A77-36163 # An adjustable spring rate suspension system T E Shoup (Houston, University, Houston, Tex.) and G E Simmonds *AIAA Journal*, vol 15, June 1977, p 865, 866 Research supported by the University of Houston

An elastic suspension spring reported by Shoup (1972) is considered In connection with its simple construction and symmetrical nonlinear behavior, the device was found to have much promise for aerospace and transportation applications The versatility of the 'elastica' suspension is further demonstrated by showing how the device can be adjusted to provide an enhanced selection of nonlinear spring rates G R

A77-36166 * # Exact solutions in oscillating airfoil theory M H Williams (Princeton University, Princeton, N.J.) *AIAA Journal*, vol 15, June 1977, p 875-877 8 refs Grant No NGR-31-001-197

A result obtained by Williams (1977) for two-dimensional airfoils oscillating in an arbitrary subsonic parallel flowfield is reformulated to show that the pressure distribution induced by any deformation can be construed from the particular solutions for heaving and pitching motions Specific formulas are presented for an oscillating control surface with a sealed gap G R

A77-36171 # Supersonic wave drag for nonplanar singularity distributions W C Chin (Boeing Commercial Airplane Co., Seattle, Wash.) *AIAA Journal* vol 15 June 1977, p 884-886

An investigation is conducted concerning the wave drag for a general distribution of sources and doublets on an arbitrarily curved surface, taking into account the linear differential equation of supersonic flow, with no linearized restrictions on the boundary conditions The derived expression extends wave drag relations obtained by Hayes (1947) to arbitrary curved surface doublet/source representations which are produced by recently developed panel-type computational methods An approach is pointed out for obtaining the total drag of an aircraft configuration G R

A77-36202 * Wear formulation for aircraft brake material sliding against steel T L Ho and M B. Peterson (Rensselaer

Polytechnic Institute, Troy, N.Y.) *Wear*, vol 43, June 1977, p 199-210 10 refs Grant No NGR-33-018-152

Predictions of wear on contemporary copper-based brake material sliding against 17-22 AS grade steel, wear testing equipment, formulation of wear, and test results are discussed An initial investigation of worn surfaces of the brake material and a mating steel rotor was carried out A wear model proposed suggests initiation of cracks at a hard particle inclusion site in the surface layer of the brake material, crack propagation allows particles to be removed by intersection of cracks Mutual relations between sliding variables, load, time, hardness, and surface temperature are studied Empirical formulas are exhibited R D V

A77-36239 * A numerical study of the unsteady leading edge separation bubble on an oscillating airfoil. J P Kreskovsky, S J Shamroth, and W R Briley (United Technologies Research Center, East Hartford, Conn.) *Computer Methods in Applied Mechanics and Engineering*, vol 11, Apr 1977, p 39-56 21 refs Contract No NAS1-11568

A preliminary study of the unsteady viscous flow in the region of an airfoil leading edge was performed, in which the interaction between the viscous and inviscid flow fields is neglected The solution method uses the finite difference form of the governing equations throughout the separated flow field and incorporates a transition model based on the integral turbulence kinetic energy equation The validity of the numerical procedure is verified by making comparisons with analytical solutions to several test problems, including unsteady flow over a plate oscillating in its own plane The method was then applied to the problem of unsteady viscous flow over a NACA 0012 airfoil oscillating sinusoidally in pitch The flow field characteristics were in qualitative agreement with experimental results The bubble moved forward on the airfoil and decreased in size as incidence was increased Viscous flow in the leading edge region was found to be quasi-steady, while bubble height varied inversely with Reynolds number P T H

A77-36390 The composite technology - Its possibilities and its risks /Hugo Junkers Lecture/ (Die Composite-Technologie - Ihre Chancen und Risiken /Hugo-Junkers-Vorlesung/). U Hutter (Stuttgart, Universität, Stuttgart, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol 1, Jan-Feb 1977, p 2-17 In German

The development of aircraft utilizing metallic sheet structures by Junkers is examined It is pointed out that the advances made in this case had only been possible because a well developed sheet-metal technology had been available as a basis for the advances For a utilization of the potential advantages related to an employment of composite materials, it is also necessary to develop first a corresponding technological base for the design and the processing of composites. Attention is given to fiber-matrix composite structures, economic developments concerning the production of carbon and boron/tungsten fibers, the structures of high-performance gliders, helicopter rotor blade developments, blades for gas turbines, the determination of the strength of multilayer shells, and the determination of conditions leading to a failure of composite structures G R

A77-36394 Nonlinear parameter identification from a vibration test (Nichtlineare Parameter-Ermittlung aus einem Schwingungsversuch). H Kohler (Vereinigte Flugtechnische Werke-Fokker GmbH, Lemwerder, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol 1, Jan-Feb 1977, p 50-57 7 refs In German

A theory for the determination of the nonlinear vibration behavior of a discrete, holonomic, elastomechanical system is described by means of a substitute system reduced, after a general survey, to two degrees of freedom The method is applied to the nonlinearities in frequency/angle of rotation diagrams of the VFM 614 lateral control system measured during a static vibration test A detailed discussion of the overall vibration behavior compared to the linear theory follows (Author)

A77-36400 * Hot-wire anemometry for in-flight measurement of aircraft wake vortices. R A Jacobsen (NASA, Ames Research Center, Flight System Research Div., Moffett Field, Calif.) *DISA Information*, Apr 1977, p 21-27 20 refs

A development program has demonstrated that hot-wire anemometry can be used successfully on an aircraft in flight to make measurements of wake vortices produced by another aircraft. The probe, whose wires were made of platinum/rhodium, 10 microns in diameter, provides unambiguous results for inflow angles less than about 35 deg off the probe axis. The high frequency response capability of the hot-wire system allows detailed measurement of the flow structure, and the study of aircraft hazards associated with wake turbulence. B J

A77-36428 Calculation of attached or partially separated flow around airfoil sections. J H Milgram (MIT, Cambridge, Mass.) *Journal of Ship Research*, vol 21, June 1977, p 69-81 16 refs

The article deals with two-dimensional airfoil theory for incompressible fluid flow. The airfoil contour has large slopes in the physical plane when the airfoil has a round leading edge, the slopes in the mapped plane are small and approach zero uniformly when the airfoil thickness/camber ratios are brought closer to zero by an affine transformation on the airfoil shape. The small slopes in the mapped plane favor use of a perturbation series. A relatively unified theory is developed for attached and partially separated (trailing-edge separation) flow patterns. The attached-flow theory is shown to be particularly appropriate for thin marine propeller sections with blunted leading edges. R D V

A77-36434 Energy and aerospace /Sixty-fifth Wilbur and Orville Wright Memorial Lecture/ R C Seamans, Jr (ERDA, Washington, D C) *Aeronautical Journal*, vol 81, Apr 1977, p 147-169 92 refs

Some ways that aerospace science can contribute to conserving or obtaining energy are discussed. Developments leading to increased fuel efficiency and the possibility of using alternative fuels for aviation are considered, as is the use of fuel-efficient lighter-than-air vehicles for transporting heavy cargo. It is suggested that remote aircraft and spacecraft sensing can be used to prospect for fossil fuels, geothermal resources, and uranium, and that data obtained from earth resources satellites can be used for planning and monitoring energy activities. The prospect of capturing solar energy in space and transmitting it for use on earth is also examined. M L

A77-36561 Air traffic control in the Soviet Union. *The Controller*, vol 15, Feb 1976, p 5, 6, 8-10

The TERCAS (Terminal and En-Route Control Automated System) to be installed in the Soviet Union with Stansaab Elektronik AB as primary contractor is discussed. The system will consist of four operational air traffic control systems: three Terminal Control Centers (TCC) at Moscow, Kiev, and Mineral'nye Vody, and an Area Control Center (ACC) adjacent to the Moscow TCC. Each operational center will utilize data from existing primary and secondary surveillance radars in addition to new radar systems, all will be fitted with radar data extractors for narrow-band data transmission. Computerized flight plans will be correlated with processed data giving automatic tracking of aircraft. Major features of the operational centers at Kiev, Moscow, and Mineral'nye Vody are described and contrasted. C K D.

A77-36562 Surveillance radar designed for improved target visibility. A. Hartley-Smith (Marconi Radar Systems, Ltd., Chelmsford, Essex, England) *The Controller*, vol 15, Feb 1976, p 27-30

The design of the S 654H radar, which operates in the 23-cm band with a performance comparable to that of 50-cm systems, is discussed. The selection of approaches to solve three major design problems - elimination of permanent echoes, clutter rejection, and moving target indicator velocity response - is described. Performance data for the system are given. C.K.D

A77-36563 The Air Traffic Control Evaluation Unit, Hurn Airport, U.K. B A Turner (Air Traffic Control Evaluation Unit, Hurn Airport, Hants., England) *The Controller*, vol 15, May 1976, p 9-14

The purposes, activities, organizational structure, and specific duties of constituent groups of the ATCEU are detailed. Evaluation tests run by real-time simulation or fast-time simulation on ATC systems are described. The operational work of the ATCEU is divided between an Executive Division and a Support Division. The ED incorporates two operations groups, their spectrum of duties in simulation programs and testing are spelled out. The Support Division incorporates an ADP group, a scientific group, radar simulation teams, and a telecommunications group. Simulation tests and training operations and interactive displays handled by these groups, and equipment at their disposal, are indicated. R D V

A77-36565 Air route surveillance radar system ARSR-3. *The Controller*, vol 15, May 1976, p 32-35

Equipment, equipment configurations, and equipment performance characteristics (of systems and components) of the ARSR-3 air route surveillance radar system for detecting false alarms and acting as primary sensor for automated ATC are described. Receivers and transmitters, antenna and pedestal, generators and digital circuitry, and frequency generators of the ARSR-3 are described, important performance data are tabulated and characterized. ARSR-3 duplex operation (two radar channels sharing a single antenna, and each transmitting at different frequency and polarization) is described. Built-in test equipment is described. R D V

A77-36566 Birds in flight - Radar observation and avoidance procedures which can be employed by air traffic controllers. M Laty (Service Technique de la Navigation Aérienne, Paris, France) *The Controller*, vol 15, May 1976, p 37-40

A77-36567 Future air traffic control systems III. *The Controller*, vol 15, Aug 1976, p 34-36, 38

The role of the pilot in the air traffic control system is examined, and design features recommended for incorporation into future air traffic control systems to ensure the optimum fulfillment of this role are discussed. Special attention is given to the problem of communications system design. The effect of such environmental factors as noise level, lighting, vibration, and confined working quarters on pilot performance is evaluated, and psychological and organizational considerations affecting the pilot's end of the air traffic control system are discussed. C K D

A77-36568 SINTEQ - A selective interrogation system for SSR. H W Cole (Marconi Radar Systems, Ltd., Chelmsford, Essex, England) *The Controller*, vol 16, Feb 1977, p 16-19

The article presents a general description of the SINTEQ secondary surveillance radar (SSR) selective interrogation system. Capability of supplanting ADSEL and DABS systems with a great reduction in the number of interrogations and suppressions, and efficient defruiting, is claimed for SINTEQ. Unique identity is conferred upon 4093 individual aircraft in a given service area (4096 minus 3 codes reserved for emergencies/failures/hijack). One sweep through 360 deg establishes range, bearing, and identity of all aircraft within radar cover, subsequent interrogation is limited to the aircraft targeted by the antenna spot beam. The way the system keeps track of targets is described, along with testing procedures. Logic modifications to enhance efficiency, further minimize unwanted interrogations, and relieve decoding/defruiting/suppression loads are considered. R D V.

A77-36569 AN/TPN-25 precision approach radar and associated units. *The Controller*, vol 16, Feb. 1977, p 27, 30-32

Some new systems with precision approach radar (PAR) and ground-controlled approach (GCA) features for flexible ATC in all weather conditions, without exorbitant purchase and operating costs, are described. Attention is focused on the Raytheon AN/TPN-25

system, but the AN/TPN-19 transportable modular system and the AN/TPN-24 airport surveillance radar are also described briefly. Advantages claimed over earlier PAR systems include lower cost, less complexity, simultaneous search and track, full digital beam control, and light weight. The computer-controlled phased array (hybrid limited scan design) of the AN/TPN-25 antenna system, a backup landing guidance technique incorporating a targetborne data link reminiscent of GCA, and a versatile precision approach and landing monitor (PALM) computer-controlled system are described. R D V

A77-36570 FAA's flight service stations in modernization process. G J de Boer. *The Controller*, vol 16, Feb 1977, p 37-43

Services provided by FAA flight service stations (FSS) for general aviation are described, and the need for modernization of FSS to eliminate delay and paperwork is emphasized. The article describes at length automated and semi-automated FSS facilities at the Atlanta FSS and the AWANS (aviation weather and NOTAM system) being run through tests at that installation. Flight plan preparation and pilot briefing services, including pilot self-briefing options, AWANS computer hardware, and other plausible AWANS applications are discussed. R D V

A77-36571 The MITRE METREK air traffic control simulation laboratory. B Morgenstern and R W Telsch (Mitre Corp, McLean, Va.) *The Controller*, vol 16, May 1977, p 22-25. 5 refs. U.S. Department of Transportation Contracts No. FA70WA-2448, No. FA69NS-162

Design, analysis, and validation of automated air traffic control (ATC) services are discussed. Attention is centered on the design of support computer algorithms and on interactive displays. The MITRE simulation system hardware and software are described. A VM/CMS (virtual memory/conversational monitor system) standard simulation facility based on an IBM 370/145 computer is described along with various schemes for operator-machine interaction, and collision avoidance. Emphasis is laid on system capability of accepting full models of traffic routes, altitude profiles, and speed profiles, fidelity aircraft models and generation of conflict-free clearances by the control system in response, operation with the basic displays and special software for the project displays. R D V

A77-36572 Automation of the low density terminal. D B Whitney (International Technical Products Corp., Washington, D C.) *The Controller*, vol 16, May 1977, p. 31-33

Criteria for deciding on ATC automation in airport terminals of low traffic density, and varieties of automatic ATC hardware available for the use of low-density terminals, are discussed. Flight safety is recognized as paramount, and attention is given to annual number of air carrier or itinerant aircraft operations, the mix of aircraft operating in the terminal area (high-performance or large commercial aircraft to be managed in same airspace as general aviation), geographical and terrain features, and regional weather conditions. Displays, handling of data blocks on approaching aircraft, automatic handoff between adjacent sectors, and automated secondary surveillance radar systems suitable for smaller terminals are described. R D V

A77-36598 # Three-parameter method for calculating a laminar boundary layer with suction (Trekhparametricheskii sposob rascheta laminarnogo pogranichnogo sloia pri nalichii otsasyvaniia). L F Kozlov (Akademiia Nauk Ukrainskoi SSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR) *Gidromekhanika*, no 35, 1977, p 40-46. 14 refs. In Russian

A simple three-parameter method for calculating a laminar boundary layer on a porous surface in the presence of suction on wing profiles and bodies of revolution in incompressible flow is set forth. The velocity field in the laminar boundary layer is approximated by a three-parameter family of curves satisfying fundamental boundary conditions on the surface and outer boundary of the

boundary layer. The curves depend on two form parameters and a suction parameter. The use of three-parameter profiles enables more precise calculations of boundary layer separation for an arbitrary velocity distribution on the outer boundary. The expression for the family of curves contains defining parameters in which only a concrete linear dimension appears - the momentum loss thickness. P T H

A77-36623 Fiber-reinforced composites as new jet engine materials (Los enfibrados como nuevos materiales para reactores). A Madroñero de la Cal and J Jiménez Clavijo (Instituto Nacional de Técnica Aeroespacial, Torrejón de Ardoz, Spain) *Inta/Conie*, Oct-Dec 1975, p 3-20. 32 refs. In Spanish

The basic physics, mechanics, and applications of fiber-reinforced composite materials are reviewed. Composites with finely dispersed reinforcements, laminar composites, filled composites including cermets, ceramic-matrix composites, and materials with such phases as sapphire whiskers, silicon fibers, boron fibers, graphite fibers are described. Organic fibers, glass fibers, metallic fibers, amorphous ceramic fibers grown on a substrate, discontinuous fibers, glass fabrics, and some molding and lay-up techniques are discussed. R D V

A77-36626 # The army picks a winner. G Costello. *Bee Hive*, vol 52, Winter-Spring, 1977, p 2-7

Advantages of the Sikorsky UH-60A helicopter which won U.S. Army approval as UTTAS candidate are presented. Lowest overall life-cycle cost, lower risk in technology and in production costs, and design based on airmobile combat experience and studies of rotorcraft combat crash/damage/fatality history are covered. Combat survivability, reduced vulnerability to hostile action, stability augmentation, load-carrying capacity, easy maintainability and repairability in the field, airframe ability to withstand a 42 ft/sec vertical crash without harm to crew and passengers, and the ability of the gearbox to continue functioning 30 to 60 min after losing all oil, are pointed out. Main and tail rotor blades, upper control surfaces, main rotor hub, and tail rotor drive shaft can survive multiple hits, and the UH-60A has achieved safe landings even with the tail rotor lost. R D V

A77-36633 New look for 'copter MM&T I - Airframe and rotor system technology. R L Spangenberg (U.S. Army, Tank Automotive Research and Development Command, Warren, Mich.) *ManTech Journal*, vol 2, Winter 1977, p 33-40

New cost-cutting approaches to the bonding and forming of rotorcraft parts are discussed as advances in helicopter manufacturing methods and technology. Use of aluminum, foam honeycomb, and fiberglass and other composites is stressed. Advances in manufacturing of composites, automatic layup of rotorcraft air frame structures, spot weld bonding and rivet bonding, and pultrusion techniques are described. Applications to airframes, control surfaces, and rotor blades are exhibited. R D V

A77-36649 # Measurement-data system for investigating the thermal stability of structures (Izmeritel'naiia informatsionnaia sistema dlia teploprochnostnykh issledovaniu konstruktsii). A I Beklemishchev, V M Brennerman, Iu S Il'in, N A Krasilova, A I Lebedeva, V M Ordynsev, E M Sinitsyna, V A Sudakov, and A A Ian'shin. *Teplovyie Napriazheniia v Elementakh Konstruktsii*, no 17, 1977, p. 107-111. In Russian

The paper describes a data acquisition and processing system called 'Prochnost', used for investigating the thermal stability of aircraft structures in high temperature conditions. The key feature of the system is elimination of the effects of resistances of lines and switches on measurement accuracy. The system consists of eight measurement channels, devices of data input and output, control panels, and a digital computer interface. B J

A77-36650 # Resistance strain gages for stability experiments at temperatures up to 300 C (Tenzorezistory dlia prochnostnogo eksperimenta pri temperaturakh do 300 C). N P Klokova, L

T Ivanova, L. N. Kamentseva, and Z. G. Gorkina *Teplovye Napriazheniya v Elementakh Konstruktsii*, no 17, 1977, p. 111-114. In Russian.

The paper presents results of performance tests of resistance strain gages, designed for the fatigue testing and large-strain testing of aircraft structures at temperatures up to 300 C. Constantan wires were used as sensitive grids in the gages, and thermally stable polymers were used as binder materials. B. J.

A77-36679 Polyphenylquinoxalines with terminal acetylene groups F. E. Arnold (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio) and R. F. Kovar (Dayton, University, Dayton, Ohio) In Bicentennial of materials, Proceedings of the Eighth National Technical Conference, Seattle, Wash., October 12-14, 1976. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1976, p. 106-113.

A new family of experimental, thermosetting oligomers, the acetylene terminated quinoxaline (ATQ) resins, are described which offer great potential for use in high temperature composite and adhesive applications. The oligomers homopolymerize by both inter- and intramolecular addition reactions leading to fused aromatic ring systems which exhibit excellent thermal and thermo-oxidative stabilities. The tailoring of molecular structures of the oligomers provides the opportunity to obtain useful compromises with respect to the processing parameters, the conditions of cure and the ultimately attained thermal and mechanical properties. (Author)

A77-36682 F-15 composite speedbrake in production R. B. Kollmansberger and M. N. Botkin (McDonnell Aircraft Co., St. Louis, Mo.) In Bicentennial of materials, Proceedings of the Eighth National Technical Conference, Seattle, Wash., October 12-14, 1976. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1976, p. 138-154. Contract No. F33615-74-C-5124.

The MCAIR F15 composite speedbrake is the first operational, high production rate graphite/epoxy structure on an Air Force weapons system. It is a large, complex configuration structure that results in a 26.5% weight savings over the metal design. Development was accomplished under Air Force funding and concluded with the successful fatigue and static tests. Computer technology is applied to the design/analysis operations and to the automated fabrication techniques such as DNC laser cutting of graphite/epoxy broadgoods. The composite speedbrake has been in production since June 1975 and over 100 assemblies have been fabricated one year later.

(Author)

A77-36684 Recent advances in nickel alloys for aerospace applications D. J. Tillack (Huntington Alloys, Inc., Huntington, W. Va.) In Bicentennial of materials, Proceedings of the Eighth National Technical Conference, Seattle, Wash., October 12-14, 1976. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1976, p. 169-181. 5 refs.

Recent advances in several areas of alloy development are examined, with emphasis on the application of these alloys to aerospace usage. Two mechanically alloyed materials are described, with emphasis on the outstanding high-temperature features of such alloys. A low-expansion high-strength alloy is described, with examples of its use in gas turbines and the Space Shuttle main engine. Properties of a fourth alloy, having high-temperature strength and oxidation resistance, are also presented. (Author)

A77-36700 Manufacture of ribs for the A7D composite outer wing. I. Petker and B. A. Stern (Composites Horizons, Pomona, Calif.) In Bicentennial of materials, Proceedings of the Eighth National Technical Conference, Seattle, Wash., October 12-14, 1976. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1976, p. 487-501. Contract No. F33615-73-C-5066.

The paper describes a prepreg/prebleed process applied to the manufacture of ribs for a composite outer wing. It is suggested that,

by paying attention to the composite microstructure, the following goals can be approached: the elimination of air and volatile matter, reactive and nonreactive, in such a manner that the resulting composite is void-free, the adjustment of resin content to a predetermined range, the uniform distribution of resin and reinforcement throughout the structure, and the placement of reinforcement with special emphasis on maintaining its linearity. M. L.

A77-36788 # Energy utilization factor in civil transport aircraft (Il fattore di utilizzazione dell'energia nei velivoli civili da trasporto) G. Guerra (Torino, Politecnico, Turin, Italy) *Ingegneria*, Mar-Apr 1977, p. 65-72. 8 refs. In Italian.

Energy utilization factor (EUF) is related to several performance parameters of civil transport aviation: aerodynamic efficiency, propulsion efficiency, and specific fuel consumption. Influence on direct operating costs by fuel consumption (now around 40% of DOC) is noted. Improvements in three efficiency factors mentioned are judged the best approach to cost effectiveness. EUF estimates are plotted for various aircraft types and various types of transportation vehicles. R. D. V.

A77-36791 # Status of silicones as fire-resistant military aircraft hydraulic fluids A. A. Conte, Jr., J. L. Hammond, and L. Stallings (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) *American Society of Lubrication Engineers, Annual Meeting, 32nd, Montreal, Canada, May 9-12, 1977, Paper 6* p. 5. 5 refs. Navy-sponsored research.

This paper updates the U.S. Navy's program on the development of a fire-resistant silicone fluid for use in military aircraft hydraulic systems. Previous attempts to develop a silicone-based fluid for currently designed systems were unsuccessful. Program goals were then redirected toward the development of a 450 K (350 F) to 478 K (400 F) fluid around which future aircraft hydraulic systems could be designed. A candidate fluid designated Nadraul MS-6, based on tetrachlorophenylmethyl siloxane incorporating dibutyl chlorosilicate as an antiwear additive, has resulted from the laboratory phase of this investigation. A 500-hour pump-loop circuit evaluation has demonstrated that the MS-6 fluid possesses suitable antiwear and thermal stability properties. A design guide based on the properties of Nadraul MS-6 is forthcoming. (Author)

A77-36963 Method of calculating flows with shock waves - Application to design of turbomachine blade profiles (Méthode de calcul d'écoulements avec ondes de choc - Application au tracé de profils d'aubages de turbomachines) H. Miton and E. Scetbon (Aix-Marseille I, Université, Marseille, France) *Académie des Sciences (Paris), Comptes Rendus, Série B - Sciences Physiques*, vol 284, no 18, May 9, 1977, p. 361-364. In French.

A numerical method of computation has been established, with the object of designing blade profiles of compressors or turbines, the characteristics of the flow along a streamline being given, the occurrence of shock waves can be considered in the computation. With the assumption of a two-dimensional inviscid and isoeenergetic flow, Euler's equations are integrated along the streamlines and their normals. Successive streamlines, computed from the first one, define the boundaries of a channel, from which the corresponding blade profile can be easily deduced. (Author)

A77-36972 Fiber optics cost models for the A-7 aircraft. R. A. Greenwell (U.S. Naval Electronics Laboratory Center, San Diego, Calif.) *Fiber and Integrated Optics*, vol 1, no 2, 1977, p. 197-225. 11 refs. Navy-sponsored research.

Presented in this article is a description of two cost models which compare fiber optic interface to alternative wire interconnect for the Airborne Light Optical Fiber Technology (ALOFT) project on the A-7 aircraft. Data for these models were collected on existing components of fiber optics and wire systems. The results of this study indicate that fiber optics, in comparison to most wire alternatives, achieves a significant reduction in total life-cycle cost and at the same time meets or exceeds the future requirements of

Electromagnetic Interference (EMI), Electromagnetic Pulse (EMP), and lightning strike vulnerability (Author)

A77-36977 A contribution to calculate the performance of multistage axial-flow compressors (Beitrag zur Berechnung von Kennfeldern mehrstufiger Axialverdichter). K G Grahl (Motoren- und Turbinen-Union München GmbH, Munich, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, Mar-Apr, 1977, p 116-122 5 refs In German Research supported by the Bundesministerium der Verteidigung

A 'relative' off-design calculation method is proposed for industrial compressor development and its validity is checked against experimental data from different compressor builds. In addition, the impact of the choice of certain main parameter values (inlet displacement thickness, outlet angle, loss coefficient, camber, stagger) on the results of the off-design calculation for high and lower speeds has been examined and discussed. The simplified stability criterion used to determine the compressor surge line is based on a rotating stall theory (Author)

A77-36978 Influence of gust modeling on the identification of derivatives of the longitudinal motion of an aircraft (Einfluss der Böenmodellierung auf die Identifizierung der Derivativa der Längsbewegung eines Flugzeugs). G Schulz (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, Mar-Apr 1977, p 123-128. 6 refs. In German

The influence of stochastic modeling of horizontal and vertical gusts on the maximum likelihood identification of derivatives of the longitudinal motion of the HFB-320 aircraft is investigated. Four different modelings of the power spectral densities of the gusts are considered. It is shown that the outputs are more influenced than the estimates of the derivatives. The best curve fit occurs for modeling of the power spectral densities of the gust by a first-order Gauss-Markoff process (Author)

A77-36979 A contribution for solving the flutter equation considering powered controls and automatic flight control (Ein Beitrag zur Lösung der Flattergleichung unter Berücksichtigung von Servosteuern und Flugregler). S Vogel (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, Mar-Apr, 1977, p 128-135 9 refs In German

A method is presented which is especially suited for solving the flutter equation containing powered controls and automatic flight control systems. The method is related to the p, k-method by Hassig, but the iteratively improved approximate solutions are calculated by means of Vieta's root theorem applied to the matrix the origin of which has been shifted. With this method it is possible to separate closely adjacent eigenvalues and also to specify the accuracy of the calculated values (Author)

A77-36980 Application of pole allocation to the design of stabilization systems, illustrated by the longitudinal motion of an aircraft (Anwendung der Polfestlegung beim Entwurf von Stabilisierungssystemen am Beispiel der Flugzeuglängsbewegung). U Hartmann and E Lonn (Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany) *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, Mar-Apr 1977, p 135-147 11 refs In German Research supported by the Bundesministerium der Verteidigung

The pole allocation method for designing a stabilization system for the longitudinal motion of an aircraft is discussed and applied to the motion of the F-4C aircraft. Certain configurations of poles and zeros are found to lead to control laws satisfying handling quality criteria. The method is also applied to the realization of an adaptive stabilization system, and in particular to an identification problem involving the adaptive structure of a second order model B J

A77-37010 # Pro-static agents in jet fuels J T Leonard (U S Navy, Naval Research Laboratory, Washington, D C) In International Congress on Electrostatics, 3rd, Grenoble, France, April 20-22, 1977, Proceedings Paris, Société de Chimie Industrielle, 1977, p 18-a to 18-e 5 refs

It has been hypothesized that many fires and explosions during the fueling of aircraft occur because the fuel is unusually electrostatically active as a result of contamination by trace amounts of pro-static agents. A study was conducted to determine if, by screening a wide variety of polar and ionic compounds and fuel additives, it would be possible to identify the types of compounds that are responsible for unusually high electrostatic activity in hydrocarbon fuels. Thirty-nine compounds and 24 fuel additives were screened for possible pro-static activity by measuring the effects of these materials on the electroconductivity and the charging tendency of silica gel-treated n-heptane B J

A77-37011 # Optimization of the reduction of the radio-electric noise created by a corona discharge on aircraft J-L Boulay (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In International Congress on Electrostatics, 3rd, Grenoble, France, April 20-22, 1977, Proceedings Paris, Société de Chimie Industrielle, 1977, p 21-a to 21-e Research supported by the Direction des Recherches et Moyens d'Essais

Three methods for reducing radioelectric noise produced by an electrostatic corona discharge on an aircraft surface are described. The methods involve, respectively, the effect of an uncoupling resistance, the principle of orthogonal uncoupling and the creation of multiple, uncorrelated discharges B J

A77-37012 # Analysis programme for static electricity on aircraft D G Douglas and J E Nanevitz (Stanford Research Institute, Menlo Park, Calif) In International Congress on Electrostatics, 3rd, Grenoble, France, April 20-22, 1977, Proceedings Paris, Société de Chimie Industrielle, 1977, p 23-a to 23-e 8 refs

The paper describes a computer program which predicts the static noise induced in an aircraft antenna with reasonable accuracy and for a wide variety of flight vehicles. The program takes account of noise sources (corona and streamer discharges), electromagnetic coupling, aircraft charging, and the equivalent noise field. The model was verified using the 707 belly antenna and the F-4 tail-cap antenna as examples B J

A77-37018 # Induced rolling moment on trailing wings. Z El-Ramly (Carleton University, Ottawa, Canada) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex, June 27-29, 1977, Paper 77-663* 9 p 18 refs National Research Council of Canada Grant No A-7799

An experimental wind tunnel test program has been conducted to investigate possible scaling parameters for the prediction of the maximum induced rolling moment on a trailing wing. Detailed variation of the induced rolling moment on a following wing in the wake of a generating wing is measured for several lead/trailing combinations. With five wings used ten different combinations were possible covering the trailing/generating span ratio of 0.24 to 1.22. The wings include both straight and swept configurations and the aspect ratio varies between 4 and 8.5. The results show that the maximum induced rolling coefficient depends on the trailing wing aspect ratio and is proportional to both the lift coefficient of the generating aircraft divided by its aspect ratio and to the square root of generating/trailing span ratio. The effect of trailing wing incidence is also examined (Author)

A77-37019 * # Implicit finite difference simulation of flow about arbitrary geometries with application to airfoils J L Steger (NASA, Ames Research Center, Moffett Field, Calif) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex, June 27-29, 1977, Paper 77-665* 15 p 32 refs

Finite difference procedures are used to solve either the Euler equations or the 'thin layer' Navier-Stokes equations subject to arbitrary boundary conditions. An automatic grid generation program is employed, and because an implicit finite difference algorithm for the flow equations is used, time steps are not severely limited when grid points are finely distributed. Computational efficiency and compatibility to vectorized computer processors is maintained by use of approximate factorization techniques. Computed results for both inviscid and viscous flow about airfoils are described and compared to various known solutions (Author)

A77-37021 * # Effect of angle of attack and Mach number on slender wing aerodynamics. L E Ericsson and J P Reding (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-667* 16 p 47 refs Contract No. NAS8-30652

An analytic theory is presented in which the classical slender wing theory is modified to account for the combined effects of large angle of attack and nonsonic Mach number on the unsteady aerodynamics. The computed results agree well with available static and dynamic experimental data for slender delta wings in the freestream Mach number range between 0 and 2.8. The method was extended to compute the unsteady aerodynamics of the space shuttle orbiter by defining an equivalent slender wing using static experimental data. The results obtained in this manner are in good agreement with dynamic experimental results for the freestream Mach number range between 0.3 and 1.2 (Author)

A77-37024 * # Rolling moments in a trailing vortex flow field. O J McMillan, R G Schwind, J N Nielsen, and M F E Dillenius (Nielsen Engineering and Research, Inc., Mountain View, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-670* 12 p 21 refs Contract No. NAS2-9398

Pressure distributions are presented which were measured on a wing in close proximity to a tip vortex of known structure generated by a larger, upstream semispan wing. Overall loads calculated by integration of these pressures are checked by independent measurements made with an identical model mounted on a force balance. Several conventional methods of wing analysis are used to predict the loads on the following wing. Strip theory is shown to give uniformly poor results for loading distribution, although predictions of overall lift and rolling moment are sometimes acceptable. Good results are obtained for overall coefficients and loading distribution by using linearized pressures in vortex-lattice theory in conjunction with a rectilinear vortex. The equivalent relation from reverse-flow theory that can be used to give economic predictions for overall loads is presented (Author)

A77-37025 * # Effect of wing fins on lift-generated wakes. V J Rossow (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-671* 12 p 16 refs

A theoretical and experimental study has been made of the effect of wing-mounted fins on the vortex wakes of subsonic aircraft. The theory is used (a) to gain an understanding of wake alleviation by vortex injection and (b) to guide the experimental investigation. Wind-tunnel tests were used to evaluate the alleviation achievable and to find the optimum values for the various fin parameters. It was found that vertical fins mounted on the upper surface of a wing could lower the wake-induced rolling moments on an encountering wing by a factor of 3 or more. The most promising fin configuration found for the Boeing 747 model is a fin positioned 48% outboard from the centerline to the wingtip with a height of 0.014 span, a chord of 0.085 span, and an 18 deg angle of attack. This fin configuration caused a 10% increase in drag but no lift penalty (Author)

A77-37026 * # Lift enhancement by an externally trapped vortex. V J Rossow (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-672* 12 p 29 refs

A theoretical study is made of the performance capabilities of a lift concept that utilizes a spanwise vortex over the upper surface of the wing. The vortex is generated by a vertical flap near the leading edge of the wing and maintained by suction through orifices in endplates at the wingtip. The analysis approximates the three-dimensional flow field with a two-dimensional configuration that is mapped by conformal transformation into the flow about a circle. Theoretical solutions for a range of flap and orifice configurations predict that section lift coefficients up to around 10 can be achieved. It is concluded that such a lift concept is applicable to STOL aircraft if the vortex can be adequately stabilized and if the endplate suction can be generated efficiently (Author)

A77-37027 # Numerical prediction of the unsteady flow field in an open cavity. C J Borland (Rockwell International Corp., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-673* 12 p 6 refs. Research supported by the Rockwell International Independent Research and Development Program

It is pointed out that in high-performance military aircraft, the acoustic environment which can exist in an open cavity can be a severe design constraint, potentially impacting the fatigue life of the internal structure or causing damage to sensitive avionics or mechanical equipment. A description is presented of an accurate prediction technique which can assess both the environment of an open cavity and the effectiveness of methods for improving the environment. Attention is given to the fluid-in-cell (FLIC) method, the application of the FLIC method to cavity flows, and the application of the predictor-corrector method to cavity flows. G R

A77-37028 # Numerical calculation of transonic potential flow about wing-fuselage combinations. D A Caughey (Cornell University, Ithaca, N Y) and A Jameson (New York University, New York, N Y) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-677* 9 p 29 refs Contracts No. N00014-77-C-0033, No. E(11-1)-3077

A method is presented for numerically calculating the transonic potential flow about rather general geometries. It is based upon a particularly simple form of the usual quasi-linear potential equation and formulated in terms of local representations of the solution and the mapping functions used to generate the finite-difference grid. Thus, all derivatives are generated numerically and there is no need to transform the equation - a formidable task when using boundary-conforming coordinate systems for complex geometries. The solution is stabilized by adding upwind bias in supersonic regions, and the difference equations are solved by relaxation. Sample results for wing-cylinder and waisted wing-fuselage combinations are presented (Author)

A77-37034 * # Form drag, skin friction, and vortex shedding frequencies for subsonic and transonic crossflows on circular cylinder. V S Murthy and W C Rose (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N Mex., June 27-29, 1977, Paper 77-687* 11 p 21 refs

A series of wind-tunnel tests covering a range of Mach numbers and Reynolds numbers in subsonic and transonic flows was conducted on a circular cylinder placed normal to the flow. Form drag coefficients were determined from surface-pressure measurements and displayed as a function of Mach number to show the drag rise phenomenon. Buried wire gages arranged on the model surface were used to measure skin-friction distributions and vortex-shedding frequencies at different flow conditions. It was found that detectable periodic shedding ceases above $M = 0.9$. The measured skin-friction

distributions indicate the positions of mean separation points clearly, these values are documented for the different flow conditions.

(Author)

A77-37046 # Hot-wire anemometry in a hypersonic turbulent boundary layer P. A. Materna (Princeton University, Princeton, N.J.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-702* 13 p 19 refs Contract No. F44620-75-C-0080

Hot-wire anemometer measurements of mean and fluctuating quantities have been obtained in a Mach 16 helium boundary layer. In the course of obtaining them, the recovery ratio of a cylinder in rarefied helium flow was found to differ from that for air. Since the hot-wires experienced substantial end losses it was also shown, theoretically and experimentally, that the end loss fraction is directly involved in the turbulence sensitivity coefficients. Mean property surveys were obtained, showing that the density varies across the boundary layer by a factor of 40. Turbulence measurements show that the root-mean-square fluctuations of mass flux reach at least 50% of the local mean.

(Author)

A77-37047 # An experimental study of the cooling effectiveness of a laminar two-dimensional tangential film in hypersonic flow. B. E. Richards (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genèse, Belgium) and J. L. Stollery (Cranfield Institute of Technology, Cranfield, Beds, England) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-703* 7 p

The paper describes an experimental study of the thermal protection of a surface, in hypersonic flow, by tangential injection of a coolant through a slot with laminar flow prevailing throughout. Heat transfer measurements were taken on a flat plate in a gun tunnel under isothermal wall conditions and the effect of slot height, streamwise position of slot, flow conditions and differing coolant gases were examined. A simple discrete layer theory was found to give fair agreement with the experiments. Optimizations of cooling effectiveness using this theory showed that hydrogen was likely to be the most efficient gas for constant mass injection rate.

(Author)

A77-37049 # Prediction of three-dimensional turbulent mixing in an ejector. A. D. DeJooe (Rockwell International Corp., Columbus Aircraft Div., Columbus, Ohio) and S. V. Patankar (Minnesota, University, Minneapolis, Minn.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-706* 9 p 10 refs.

A parabolic three-dimensional finite-difference method incorporating a two-equation model for turbulence closure is used to predict the spreading of a hypermixing turbulent jet within a thrust augmenting ejector. A hypermixing nozzle has an alternating exit causing the formation of streamwise vortices which increases the turbulent mixing. Predicted mainstream velocity profiles for hypermixing jets are compared with experimental data. The formation of the downstream vortices is shown. The selection of initial conditions and the effect of changing initial turbulence levels are also described.

(Author)

A77-37050 # Optimization of axisymmetric thrust-augmenting ejectors. T. C. Tai (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-707* 9 p 17 refs Navy-supported research.

A numerical procedure has been developed for designing compact ejectors for V/STOL propulsion and/or reaction control systems. The procedure uses a variational approach coupled with a finite difference scheme to optimize the diffuser contour and mixing section geometry of axisymmetric thrust-augmenting ejectors. For a given primary flow condition, the ejector can be optimized for

minimum overall length or maximum thrust, subject to the constraints imposed by the desired thrust augmentation or the fixed overall length. Illustrations demonstrate that an increase in thrust of about 38 per cent can be accomplished at a reduction of six per cent in the overall ejector length. The results also indicate that ejector performance can be further improved by using more sophisticated nozzle arrangements.

(Author)

A77-37055 * # A two-dimensional cascade solution using minimized surface singularity density distributions - with application to film cooled turbine blades E. McFarland, W. Tabakoff, and A. Hamed (Cincinnati, University, Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-715* 10 p 14 refs Grant No. NGR-36-004-064

An investigation of the effects of coolant injection on the aerodynamic performance of cooled turbine blades is presented. The coolant injection is modeled in the inviscid irrotational adiabatic flow analysis through the cascade using the distributed singularities approach. The resulting integral equations are solved using a minimized surface singularity density criteria. The aerodynamic performance was evaluated using this solution in conjunction with an existing mixing theory analysis. The results of the present analysis are compared with experimental measurements in cold flow tests.

(Author)

A77-37056 * # The effect of blade sweep on propeller performance. J. P. Sullivan (Purdue University, West Lafayette, Ind.) *American Institute of Aeronautics and Astronautics, Fluid and Plasmadynamics Conference, 10th, Albuquerque, N. Mex., June 27-29, 1977, Paper 77-716* 8 p 7 refs NASA-supported research

The advanced propeller developed for high Mach number cruise incorporates swept blades to reduce compressibility losses. In order to evaluate the induced flow-field vortex lattice methods are applied to a swept propeller blade. The blade is modeled by a radial distribution of helical horseshoe vortices with a single swept bound vortex at the quarter chord and the control point at the three-quarter chord of each radial section. The results of numerical calculations show that the power coefficient decreases as the blade is swept and the power loading distribution shifts inboard.

(Author)

STAR ENTRIES

N77-24052*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field Calif
DYNAMICS OF ULTRALIGHT AIRCRAFT MOTION IN VERTICAL GUSTS
Robert T Jones Apr 1977 12 p refs
(NASA-TM-X-73228 A-6947) Avail NTIS HC A02/MF A01
CSCL 01A

Gust load calculations are extended to the range of conditions encountered by ultralight aircraft such as hang gliders. Having wing loadings of the order of 5 kg/sq m, these gliders acquire a substantial fraction of the motion of a gust within a distance of 1 or 2 m. Comparative loads and displacements for a small powered airplane having a wing loading of 50 kg sq m and for a commercial jet with 500 kg sq m are shown. Author

N77-24053*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field, Calif
DYNAMICS OF ULTRALIGHT AIRCRAFT DIVE RECOVERY OF HANG GLIDERS
Robert T Jones May 1977 15 p refs
(NASA-TM-X-73229 A-6989) Avail NTIS HC A02/MF A01
CSCL 01A

Longitudinal control of a hang glider by weight shift is not always adequate for recovery from a vertical dive. According to Lanchester's phugoid theory, recovery from rest to horizontal flight ought to be possible within a distance equal to three times the height of fall needed to acquire level flight velocity. A hang glider, having a wing loading of 5 kg sq m and capable of developing a lift coefficient of 1.0 should recover to horizontal flight within a vertical distance of about 12 m. The minimum recovery distance can be closely approached if the glider is equipped with a small all-moveable tail surface having sufficient upward deflection. Author

N77-24054# RCA Government and Commercial Systems
Burlington, Mass. Automated Systems Div
FIELD EVALUATION OF UH-1 HELICOPTER INSPECTION SYSTEMS. PROJECT INSPECT, PHASE 2 Final Report, 1 May 1974 - 31 May 1976
Fred W Hohn, Bruce B Wierenga et al Nov 1976 248 p refs
(Contract DAAJ02-74-C-0044)
(AD-A033721, USAAMRDL-TR-76-27) Avail NTIS
HC A11/MF A01 CSCL 15/5

Project Inspect was established to analyze aircraft maintenance scheduled inspections and to design an improved schedule inspection scheme that will function effectively in the era of the volunteer Army. Various priorities associated with preventive maintenance scheduled inspection systems of Army aircraft were studied, and the resulting restructuring of these systems is based on the analysis of historical data and the modeling results of a developed computer program, MAVIS (Model for Analysis of Vehicle Inspection Systems). The output of this effort indicated that proper scheduling of individual component inspections based on failure and failure detection historical data permits an increase in inspection intervals resulting in increased efficiency and maintenance cost savings. Project Inspect then developed a phased checklist for the UH-1H Helicopter. The implementation of a scientifically derived phased inspection schedule with opened intervals should result in greater inspection efficiency, reduced maintenance costs, and increased operational readiness. GRA

N77-24055*# Kaman Aerospace Corp., Bloomfield Conn
DESIGN STUDY OF A FEEDBACK CONTROL SYSTEM FOR

THE MULTICYCLIC FLAP SYSTEM ROTOR (MFS) Final Report
R Weisbrich, R Perley, and H Howes 21 Jan 1977 90 p refs
(Contract NAS2-8726)
(NASA-CR-151960, R-1494) Avail NTIS HC A05/MF A01
CSCL 01A

The feasibility of automatically providing higher harmonic control to a deflectable control flap at the tip of a helicopter rotor blade through feedback of selected independent parameter was investigated. Control parameters were selected for input to the feedback system. A preliminary circuit was designed to condition the selected parameters, weigh limiting factors, and provide a proper output signal to the multi-cyclic control actuators. Results indicate that feedback control for the higher harmonic is feasible; however, design for a flight system requires an extension of the present analysis which was done for one flight condition - 120 kts, 11 500 lbs gross weight and level flight. Author

N77-24056*# Kanner (Leo) Associates Redwood City Calif
QUANTITATIVE STUDY OF THREE-DIMENSIONAL FLOW FIELDS AROUND FLIGHT VEHICLES IN THE CASE OF SUPERSONIC FLOW BY MEANS OF OPTICAL METHODS
G Schwarz Washington NASA May 1977 24 p refs Transl into ENGLISH of paper 76-172, presented at the 9th Ann Congr of the Ger Soc for Aeron and Astronautics, Munich, 14-16 Sep 1976 16 p
(Contract NASw-2790)
(NASA-TT-F-17428) Avail NTIS HC A02/MF A01 CSCL 01A

Asymmetrical three dimensional density fields around bodies in a supersonic flow are evaluated using interferograms, schlieren photography and tinged photographs. Author

N77-24059*# National Aeronautics and Space Administration
Langley Research Center, Langley Station, Va
THEORETICAL STUDY OF THE EFFECT OF GROUND PROXIMITY ON THE INDUCED EFFICIENCY OF HELICOPTER ROTORS
Harry H Heyson 3 May 1977 90 p refs
(NASA-TM-X-71951) Avail NTIS HC A05/MF A01 CSCL 01A

A study of rotors in forward flight within ground effect showed that the ground-induced interference is an upwash and a decrease in forward velocity. The interference velocities are large, oppose the normal flow through the rotor, and have large effects on the induced efficiency. Hovering with small ground clearances may result in significant blade stall. As speed is increased from hover in ground effect, power initially increases rather than decreases. At very low heights above the ground, the power requirements become nonlinear with speed as a result of the streamwise interference. The streamwise interference becomes greater as the wake approaches the ground and eventually distorts the wake to form the ground vortex which contributes to certain observed directional stability problems. Author

N77-24060*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field Calif
INVESTIGATION OF INLET CONCEPTS FOR MANEUVER IMPROVEMENT AT TRANSONIC SPEEDS
Eldon Latham, John Gawienowski and Frank Menwether Apr 1977 61 p ref
(NASA-TM-X-73215, A-6952) Avail NTIS HC A04/MF A01
CSCL 01A

A 15 percent scale lightweight fighter type inlet forebody was tested in the Ames 14 foot transonic wind tunnel at Mach numbers of 0.7, 0.9, and 1.04. The inlet was a two dimensional horizontal ramp system designed for a Mach number of 2.2. Four inlet devices designed to prevent or delay cowl-lip boundary layer separation or to improve the inlet internal flow characteristics at high angles of attack were investigated. The devices used to control cowl-lip separation consisted of cowl leading edge flaps, slotted flaps and tangential blowing. To improve the internal flow characteristics, discrete jet nozzle flows were directed downstream and parallel to the duct surface in the subsonic

diffuser to energize the wall boundary layer. The discrete jets used in the subsonic diffuser were also tested in combination with each of the cowl leading edge devices. Test measurements included engine-face total pressure recovery, steady state distortion, dynamic distortion, duct boundary layer profiles, and duct-surface static pressures. Author

N77-24081* National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
AERODYNAMIC CHARACTERISTICS AT MACH 6 OF A HYPERSONIC RESEARCH AIRPLANE CONCEPT HAVING A 70 DEG SWEEP DELTA WING
 Louis E Clark and Christine B Richie Washington May 1977 60 p refs
 (NASA-TM-X-3475, L-10712) Avail NTIS HC A04/MF A01 CSCL 01A

The hypersonic aerodynamic characteristics of an air-launched, delta-wing research aircraft concept were investigated at Mach 6. The effect of various components such as nose shape, wing camber, wing location, center vertical tail, wing tip fins, forward delta wing, engine nacelle, and speed brakes was also studied. Tests were conducted with a 0.021 scale model at a Reynolds number, based on model length, of 10.5 million and over an angle of attack range from -4 deg to 20 deg. Results show that most configurations with a center vertical tail have static longitudinal stability at trim, static directional stability at angles of attack up to 12 deg, and static lateral stability throughout the angle of attack range. Configurations with wing tip fins generally have static longitudinal stability at trim, have lateral stability at angles of attack above 8 deg, and are directionally unstable over the angle of attack range. Author

N77-24082* National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
CALCULATIONS, AND COMPARISON WITH AN IDEAL MINIMUM, OF TRIMMED DRAG FOR CONVENTIONAL AND CANARD CONFIGURATIONS HAVING VARIOUS LEVELS OF STATIC STABILITY
 Milton D McLaughlin Washington May 1977 24 p refs
 (NASA-TN-D-8391, L-11016) Avail NTIS HC A02/MF A01 CSCL 01A

Classical drag equations were used to calculate total and induced drag and ratios of stabilizer lift to wing lift for a variety of conventional and canard configurations. The flight efficiencies of such configurations that are trimmed in pitch and have various values of static margin are evaluated. Classical calculation methods are compared with more modern lifting surface theory. Author

N77-24083* Aeronautical Research Inst of Sweden, Stockholm Aerodynamics Dept
WIND TUNNEL MEASUREMENTS IN THE BOUNDARY LAYER ON A 3-D SWEEP WING. Final Report
 A Bertelrud 1976 112 p refs
 (Contracts F-INK-82223-74-001-07-001, F-INK-82223-75-007-07-001, F-INK-82223-76-001-21-001) (FFA-TN-AU-1191) Avail NTIS HC A06/MF A01

Measurements in a low speed wind tunnel are reported. The tests are part of a project concerning extrapolation from wind tunnel to flight, and comparative flight tests are planned. The wing was the outer part of the actual wing of a SAAB 32 Lansen attack aircraft and had natural service roughness. The wing was tested at angles of attack from zero to 12 deg (geometrical), and in a unit Reynolds number range of 0.7 to 3.4x10 to the 6th power. Some wake profile measurements are also included. Flow visualizations showed that the surface streamlines were approximately straight and parallel, and from other smoke and tuft tests (at various surface distances) the velocity profiles appear to have only moderate crossflow components. The profiles were measured by means of total head rakes and the local skin friction was measured with Preston tubes and surface total head/static probes. The results indicated that these two methods differ from the Clauser chart generally by less than 5%, despite relatively strong pressure gradients.

The wing had leading edge separation type, and tests with tape as transition trip near the leading edge explained some phenomena observed in earlier flight tests with aircraft of the same type.

Author (ESA)

N77-24085* European Space Agency, Paris (France)
UNSTEADY PRESSURE MEASUREMENTS IN ROTOR BLADE TIPS WITH INCIDENCE IN INCOMPRESSIBLE FLOW

Hermann Triebstein Apr 1977 58 p refs. Transl into ENGLISH of 'Instationaere Druckverteilungsmessungen an angestellten Rotorblattspitzen in inkompressibler Stroemung' DFVLR, Goettingen, West Ger. Report DLR-FB-76-42, 11 Aug 1976. Original report in GERMAN previously announced as N77-20038. Original German report available from DFVLR, Cologne DM 28 70 (ESA-TT-374, DLR-FB-76-42) Avail NTIS HC A04/MF A01

The measurement of unsteady pressure on harmonically oscillating rotor blade tips, in incompressible subsonic flow is dealt with. The measurements were made in a subsonic wind tunnel. The pressure was measured in five sections, allowing the three-dimensionality of the pressure distributions to be well observed. The flow speed was $V = 45$ m/s and the oscillation frequencies were $f = 2, 4$, and 6 Hz. The oscillation amplitudes ran from $B = 1$ to 3 deg and the angles of attack were $0, 3, 6, 9$, and 12 deg. Test facilities are described. Author (ESA)

N77-24088* Air Force Inst of Tech, Wright-Patterson AFB Ohio School of Engineering
STABILITY AND CONTROL CHARACTERISTICS OF THE WINGLET CONFIGURED KC-135A. M S Thesis
 Kent R Crenshaw Dec 1976 193 p refs
 (AD-A034940, GAE/MC/76D-5) Avail NTIS HC A09/MF A01 CSCL 01/3

Using the Boeing FLEXSTAB digital computer system, rigid and elastic models of the winglet configured KC-135A are made. With a rigid analysis, the winglets reduce total drag from 2 to almost 8% with improvements both laterally and longitudinally in static stability. Dynamically the rigid winglet model is more stable laterally but slightly more oscillatory longitudinally. The lateral dutch roll mode damping ratio increased with winglets from 3 to 12% with only a 3% increase in frequency. Elastic static stability is still improved both laterally and longitudinally with winglets and dynamically the winglets improve lateral stability with very little effect longitudinally. With aeroelastic effects the overall benefit derived from winglet application to the model is less. However no significant detrimental effects due to winglets are found. GRA

N77-24073* Naval Ship Research and Development Center Bethesda, Md Aviation and Surface Effects Dept
THEORY OF POWER AUGMENTED RAM LIFT AT ZERO FORWARD SPEED. Interim Report
 Harvey R Chaplin and Harvey R Chaplin Feb 1976 14 p refs
 (AD-A033673, DTNSRDC/ASED-365) Avail NTIS HC A02/MF A01 CSCL 20/4

Recent experiments by Huffman and Jackson demonstrated the possibility of an air cushion operating mode for an aircraft with low aspect ratio endplated wings wherein the propulsion system is mounted forward of the wing and exhausted into the space between the wing and the ground to generate high pressures for wing lift at zero forward speed. Gallington has derived two-dimensional potential flows relevant to this phenomenon, but applying to larger ratios of propulsive jet area to leading edge air gap area (height of wing above ground times wing span) than were employed in the experiments. In this report simple momentum theory is applied to obtain performance estimates for a range of jet area ratios from zero to the limiting cases of the potential flow solutions. Reasonable agreement with experiment is found suggesting that two-dimensional flow models may give useful estimates of the performance potential of such systems. It is found that under conditions such that a large fraction of the propulsion system thrust is recovered as useful propulsive thrust, the ratio of lift to thrust is very sensitive to the jet area ratio and optimum performance is obtained for jet area ratios approaching unity. Additional experiments are

needed covering the full range of jet area ratios, to evaluate the practical potential of power augmented ram lift systems

Author (GRA)

N77-24075# National Transportation Safety Board, Washington, D C

AIRCRAFT ACCIDENT REPORTS BRIEF FORMAT CIVIL AVIATION, ISSUE NUMBER 2, 1976 ACCIDENTS

15 Dec 1976 519 p

(NTSB-BA-76-7) Avail NTIS HC A22/MF A01

The facts, conditions circumstances, and probable causes of 899 randomly selected general aviation accidents occurring in U S civil aviation operations during calendar year 1976 are described in brief format Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light pilot certificate injuries and causal factors

Author

N77-24076*# National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif

NASA AVIATION SAFETY REPORTING SYSTEM Quarterly Report, 15 Oct 1976 - 14 Jan 1977

Washington May 1977 74 p refs Prepared in cooperation with Battelle Columbus Labs, Mountain View, Calif

(NASA-TM-X-3546 A-7001) Avail NTIS HC A04/MF A01 CSCL 01C

During the third quarter of operation of the Aviation Safety Reporting System (ASRS) 1429 reports concerning aviation safety were received from pilots, air traffic controllers, and others in the national aviation system Details of the administration and results of the program are discussed The design and construction of the ASRS data base are briefly presented Altitude deviations and potential aircraft conflicts associated with misunderstood clearances were studied and the results are discussed Summary data regarding alert bulletins, examples of alert bulletins and responses to them and a sample of deidentified ASRS reports are provided

Author

N77-24077# Honeywell, Inc, Minneapolis, Minn Systems and Research Center

DEVELOPMENT OF A HYDROFLUIDIC VERNIER ROCKET CONTROL SYSTEM FOR EJECTION SEAT STABILIZATION Final Report, 1 Mar - 1 Nov 1976

R V Burton and R B Beale Dec 1976 63 p refs

(Contract N00019-76-C-0374, WF53532403)

(AD-A034543, F0440-FR, Honeywell-77-SRC/1) Avail NTIS HC A04/MF A01 CSCL 01/3

A feasibility demonstration model of a fluidic thrust vector control (FTVC) system was designed, fabricated, and tested for pitch stabilization of ejection seats using the STAPAC vernier rocket The control system includes a rate sensor, amplifier, attitude memory, and a position-controlled hydrofluidic servoactuator The measured dynamic response of the control system closely matched the theoretical specifications for stable attitude control of the seat The hardware was tested on a hydraulic rate table without rocket firing

Author (GRA)

N77-24082*# Champlain Technology, Inc, West Palm Beach Fla

AN AVIONICS SENSITIVITY STUDY VOLUME 1 OPERATIONAL CONSIDERATIONS Final Report, Aug 1975 - Sep. 1976

Ronald W Scott and Edwin D McConkey Sep 1976 230 p refs Prepared for Systems Control, Inc, Palo Alto, Calif

(Contract NAS1-14144) (NASA-CR-145107) Avail NTIS HC A11/MF A01 CSCL 17G

Equipment and operational concepts affecting aircraft in the terminal area are reported Curved approach applications and modified climb and descent procedures for minimum fuel consumption are considered The curved approach study involves the application of MLS guidance to enable execution of the current visual approach to Washington National Airport under instrument flight conditions The operational significance and the flight path control requirements involved in the application of

curved approach paths to this situation are considered Alternative flight path control regimes are considered to achieve minimum fuel consumption subject to constraints related to air traffic control requirements, flight crew and passenger reactions, and airframe and powerplant limitations

Author

N77-24083*# Systems Control Inc, Palo Alto, Calif
AN AVIONICS SENSITIVITY STUDY VOLUME 2 EVALUATION OF AIRBORNE NAVIGATION SYSTEM PERFORMANCE DURING RNAV/MLS TRANSITION Final Report, Aug 1975 - Sep 1976

Walter Heine Sep 1976 115 p refs

(Contract NAS1-14144)

(NASA-CR-145108) Avail NTIS HC A06/MF A01 CSCL 17G

A computer simulation was modified to generate a suitable data base for performance of an avionics sensitivity study during RNAV/MLS transition The avionics sensitivity data provides information necessary to establish requirements for additional guidance law design during transition and to establish airspace requirements for maneuvering to null out any residual RNAV errors upon MLS transition The data base is also beneficial as planning information for subsequent flight testing

Author

N77-24084*# Systems Control, Inc, Palo Alto, Calif
AN AVIONICS SENSITIVITY STUDY VOLUME 3 AUTOMATED RNAV/MLS TRANSITION

Jaxant S Karmarkar Mar 1977 36 p refs

(Contract NAS1-14144)

(NASA-CR-145109) Avail NTIS HC A03/MF A01 CSCL 17G

An automated algorithm for transitioning from RNAV to MLS is described The algorithm generates guidance commands to enable the pilot to automatically switch from RNAV to MLS and effectively correct any offset errors during this transition Software/hardware implementation details pertinent to the TCV Boeing 737 avionics are also considered

Author

N77-24087# National Aviation Facilities Experimental Center, Atlantic City, N J

APPLICATIONS OF THE SIMULATION MODEL FOR AIR TRAFFIC CONTROL COMMUNICATIONS Interim Report, Jul 1974 - Jul. 1975

J Stuart Hunter and D A Hsu Feb 1977 254 p refs Prepared in cooperation with Princeton Univ

(Contract DOT-FA72NA-741)

(AD-A036738, FAA-NA-75-180, FAA-RD-76-19) Avail NTIS HC A12/MF A01 CSCL 17/7

The simulation program for air traffic control (ATC) communications, its structure validation, and applications is reviewed The model, constructed using ATC communications data from the New York Center, was checked against ATC communications data from Houston with excellent results Studies of the applications of the model are described with respect to communications capacity and queuing, the effects of reducing the number of transmissions per transaction, the effects of tone-bursts of different duration, and the sensitivity of communication responses to changes in various input variables The construction of general simulations for sector types, as opposed to individual sectors, is described Queuing time analyses and forecasting for ATC communications are reported

Author

N77-24088# Systems Control, Inc, Palo Alto, Calif Champlain Technology Industries

TERMINAL AREA DESIGN ANALYSIS AND VALIDATION OF RNAV TASK FORCE CONCEPTS Final Report

E D McConkey Oct 1975 542 p refs

(Contract DOT-FA72WA-3098)

(AD-A037022, FAA-RD-76-194)

Avail NTIS HC A23/MF A01 CSCL 17/7

Area navigation (RNAV) terminal area design guidelines for application to medium and high density terminal areas are presented The design concepts proposed by the FAA/Industry RNAV Task Force were utilized in the development of initial time-phased 2d terminal area designs for Chicago, Denver, Miami, New Orleans, New York Philadelphia, and San Francisco The

time phases correspond to three time periods. The 1972 to 1977 to 19 and 1977 82 transition period design were analyzed in conjunction with a real time simulation to confirm the pilots and controllers' capability to operate efficiently in a mixed VOR/RNAV environment. The post-1982 designs were subjected to a user economic impact analysis to determine the effects of route length and altitude restrictions on fuel and time. Two 100 percent fixed gradient VNAV designs were developed for New York and New Orleans using task force concepts and were analyzed for their impact on the user and the system. Author

N77-24090# Institute for Defense Analyses, Arlington, Va Science, and Technology Div

A REVIEW AND ANALYSIS OF THE MITRE BEACON COLLISION AVOIDANCE SYSTEM Final Report, Sep 1976 - Sep 1976

James J Bagnall, Jr., Lawrence R Dausin, Irvin W Kay, and Arthur Krinitz Oct 1976 209 p refs (Contract DOT-FA74WA-3498)

(AD-A037225 IDA Study S-481, FAA-RD-77-2) Avail NTIS HC A10/MF A01 CSCL 17/7

MCAS is an active collision avoidance system which makes use of air traffic control radar beacon system (ATCRBS) transponders already installed in many aircraft. However because the system is active, its design assumes that airborne MCAS interrogator equipment will be limited to about ten percent of the flying population in order to avoid excessive garble for its own purposes and interference with regular ATCRBS ground stations. MCAS uses the same threat logic for encounters between MCAS-equipped aircraft which was recommended by ANTC-117 and its performance suffers the same deficiencies resulting from the use of that logic as predicted in previous studies. These deficiencies are a high natural alarm rate due to a lack of certain parameter data, such as bearing rate and relative acceleration, and/or less than safe alarm criteria resulting from trade-offs intended to reduce the alarm rate. For encounters with ATCRBS transponder equipped aircraft, a special, so-called remitter logic which has similar deficiencies was developed. Author

N77-24091# Lincoln Lab, Mass Inst of Tech Lexington
DEVELOPMENT OF A DISCRETE ADDRESS BEACON SYSTEM Quarterly Technical Summary, 1 Oct - 31 Dec 1976

1 Jan 1977 50 p (Contracts DOT-FA72WAI-261, F19628-76-C-0002) (AD-A037130, FAA-RD-77-7) Avail NTIS HC A03/MF A01 CSCL 17/7

Analytical studies, laboratory and flight experiments, and software developments supporting the concept feasibility and performance definition phase of the FAA discrete address beacon system program are reported. Author

N77-24092# Air Force Flight Test Center, Edwards AFB, Calif
INERTIAL NAVIGATION SYSTEMS TESTING HANDBOOKS

Larry D Plews, Charles W Brinkley, and Kenneth E Reeser Jul 1976 185 p refs (AD-A034921, AFFTC-TIH-76-1) Avail NTIS HC A09/MF A01 CSCL 17/7

This handbook describes the methods being used in testing an inertial navigation system at the Air Force Flight Test Center (AFFTC). Future technological advances, deviations for peculiar characteristics of individual test programs, and cost constraints may necessitate other methods being used in some cases. A background on inertial navigation systems, flight testing, and documentation of computer software developed for post-flight reduction of data is presented. Author (GRA)

N77-24093# Federal Aviation Administration, Washington, D C
Systems Research and Development Service

SRDS TECHNICAL PROGRAM DOCUMENT. FISCAL YEAR 1977 ENGINEERING AND DEVELOPMENT APPROVED PROGRAMS

Oct 1976 149 p (AD-A034195) Avail NTIS HC A07/MF A01 CSCL 17/7

The report contains Research and Technology Resumes which reflect Systems Research and Development Service, Federal Aviation Administration, approved subprograms. These resumes identify the technical objective approach, milestones scheduled for accomplishment, end-item products, FY-76 accomplishments, and source of requirements. GRA

N77-24097*# Sikorsky Aircraft, Stratford Conn
STUDY TO INVESTIGATE DESIGN, FABRICATION AND TEST OF LOW COST CONCEPTS FOR LARGE HYBRID COMPOSITE HELICOPTER FUSELAGE, PHASE 2

K M Adams and J J Lucas Apr 1977 118 p refs (Contract NAS1-13479) (NASA-CR-145167) Avail NTIS HC A06/MF A01 CSCL 01C

The development of a frame/stringer/skin fabrication technique for composite airframe construction was studied as a low cost approach to the manufacture of larger helicopter airframe components. A center cabin aluminum airframe section of the Sikorsky CH-53D was selected for evaluation as a composite structure. The design, as developed, is composed of a woven KEVLAR R-49/epoxy skin and graphite/epoxy frames and stringers. The single cure concept is made possible by the utilization of pre-molded foam cores over which the graphite/epoxy pre-impregnated frame and stringer reinforcements are positioned. Bolted composite channel sections were selected as the optimum joint construction. The applicability of the single cure concept to larger realistic curved airframe sections, and the durability of the composite structure in a realistic spectrum fatigue environment, was described. Author

N77-24098*# National Aeronautics and Space Administration
Ames Research Center Moffett Field, Calif
THRUST AUGMENTOR APPLICATION FOR STOL AND V/STOL

Thomas N Aiken Jun 1977 10 p refs (NASA-TM-X-73241, A-7020) Avail NTIS HC A02/MF A01 CSCL 01C

A general parametric description is suggested for thrust augmentor application to STOL and V/STOL aircraft. The parameters and their relationships are discussed using several aircraft augmentor integration problems. For a STOL transport design, the ram drag is a key consideration, limiting the maximum gross augmentation that can be utilized. Maximizing gross augmentation and balancing the aircraft are key considerations for a V/STOL fighter design. Results from wind tunnel investigations on several different thrust augmentor concepts and system studies on STOL transport designs are also included. Author

N77-24099*# National Aeronautics and Space Administration
Langley Research Center, Langley Station, Va
A METHOD FOR MEASURING AIRCRAFT HEIGHT AND VELOCITY USING DUAL TELEVISION CAMERAS

W Robert Young 4 Jan 1977 18 p (NASA-TM-X-72829) Avail NTIS HC A02/MF A01 CSCL 01C

A unique electronic optical technique, consisting of two closed circuit television cameras and timing electronics, was devised to measure an aircraft's horizontal velocity and height above ground without the need for airborne cooperative devices. The system is intended to be used where the aircraft has a predictable flight path and a height of less than 660 meters (2,000 feet) at or near the end of an air terminal runway, but is suitable for greater aircraft altitudes whenever the aircraft remains visible. Two television cameras, pointed at zenith, are placed in line with the expected path of travel of the aircraft. Velocity is determined by measuring the time it takes the aircraft to travel the measured distance between cameras. Height is determined by correlating this speed with the time required to cross the field of view of either camera. Preliminary tests with a breadboard version of the system and a small model aircraft indicate the technique is feasible. Author

N77-24100*# National Aeronautics and Space Administration
Hugh L Dryden Flight Research Center, Edwards, Calif
FLIGHT-MEASURED LIFT AND DRAG CHARACTERISTICS

OF A LARGE, FLEXIBLE, HIGH SUPERSONIC CRUISE AIRPLANE

Henry H Armaiz Washington May 1977 62 p refs
(NASA-TM-X-3532, H-913) Avail NTIS HC A04/MF A01 CSCI 01C

Flight measurements of lift, drag, and angle of attack were obtained for the XB-70 airplane, a large, flexible, high supersonic cruise airplane. This airplane had a length of over 57 meters, a takeoff gross mass of over 226,800 kilograms, and a design cruise speed of Mach 3 at an altitude of 21,340 meters. The performance measurements were made at Mach numbers from 0.72 to 3.07 and altitudes from approximately 7620 meters to 21,340 meters. The measurements were made to provide data for evaluating the techniques presently being used to design and predict the performance of aircraft in this category. Such performance characteristics as drag polars, lift-curve slopes, and maximum lift-to-drag ratios were derived from the flight data. The base drag of the airplane, changes in airplane drag with changes in engine power setting at transonic speeds, and the magnitude of the drag components of the propulsion system are also discussed. Author

R77-24101# Georgia Inst of Tech, Atlanta HELICOPTER HOVERING PERFORMANCE STUDIES. 1. VORTEX WAKE ANALYSIS. 2. TEST FACILITY. 3. BLADE TIP PRESSURE DISTRIBUTIONS. Final Technical Report. 1 Sep. 1973 - 31 Oct. 1976

Robin B Gray, Howard M McMahon, George T Bird, John G Palfrey, Satish S Samant, and T P Shivananda Oct 1976 82 p refs

(Grants DA-ARO(D)-31-124-73-G184, DAAG29-76-G-0007) (AD-A034093, ARO-11630 1-E) Avail NTIS HC A05/MF A01 CSCI 01/3

Results are presented from studies of several problem areas which are related to helicopter hovering performance prediction. A working hypothesis is described for including the tip vortex core effect in a vortex wake analysis and it is shown that the tip vortex geometry in the near wake can be calculated with good accuracy for rotors having fewer than five blades. A hovering model rotor test facility of reduced size is described. Data from this facility include measured pressure distributions on the tip of a single-bladed rotor. Author (GRA)

R77-24102# North Carolina State Univ, Raleigh Dept of Mechanical and Aerospace Engineering AN EXPERIMENTAL INVESTIGATION OF FAVORABLE INTERFERENCE EFFECTS FROM A WING AND PROPRORATOR M.S. Thesis

Steven Lytle Griffith 1976 67 p refs
(Contract DAHC04-75-C-0023, Grant DAHC04-75-G-0007) (AD-A034075) Avail NTIS HC A04/MF A01 CSCI 01/3

Although research on V/STOL aircraft has been extensive, there are other covertiplane configurations yet to be studied. Previous investigations of tilting propeller concepts have considered the overall aerodynamic characteristics of specific designs. It is the purpose of this research to experimentally investigate the lift and drag characteristics of a constant-pitch propeller and wing interaction system in the North Carolina State University subsonic wind tunnel. The testing system consisted of five basic parts, the propeller and wing models, the North Carolina State University subsonic wind tunnel, the strain gage balance system, the system instrumentation and the propeller alignment, drive and shaft assembly. GRA

R77-24104# McDonnell Aircraft Co, St Louis, Mo TURBINE ENGINE MULTI-MISSION PROPULSION SIMULATOR WIND TUNNEL DEMONSTRATION. Final Report, Jul 1973 - 30 Oct. 1976

M F Eigenmann, R L Bear, and T C Chandler Wright-Patterson AFB, Ohio AFAPL Nov 1976 350 p refs
(Contract F33615-73-C-2051, AF Proj 668A) (AD-A034282, AFAPL-TR-76-73) Avail NTIS HC A15/MF A01 CSCI 21/5

A turbine engine multi-mission propulsion simulator developed by the Air Force Aero Propulsion Laboratory (AFAPL) to

permit improved aircraft performance prediction capability through the simultaneous simulation of inlet/airframe/nozzle flowfields, was successfully demonstrated in a wind tunnel model tested in the Arnold Engineering Development Center 16 ft Transonic Tunnel. The model tested is simple, featuring the forebody, inlet and nozzle of an advanced fighter aircraft, but no wings or tail surfaces. It is adaptable to three different test modes - simulator - equipped conventional aero flow-through and conventional jet effects, and provides for the simultaneous measurement of the total airframe, aft-end and simulator forces and moments. Extensive pressure instrumentation is also provided on the fuselage for flowfield interaction studies. Wind tunnel test data was obtained from Mach 0.6 to 1.45, and at angles of attack from -16 to 16 degrees. The results of the test indicate that the propulsion simulator is a viable wind tunnel test tool that can be effectively operated under realistic test conditions. Comparison of the aerodynamic performance of this configuration, as obtained from both simulator and conventional test techniques, showed relatively small differences, thereby indicating small inlet/aft-end flowfield interactions for this inlet/nozzle spacing. Data repeatability obtained with the simulator model was comparable to that obtained on the conventional models. Author (GRA)

R77-24105# Air Force Inst of Tech, Wright-Patterson AFB, Ohio School of Engineering SYSTEM SIMULATION IN AIRCRAFT LANDING GEAR AND TIRE DEVELOPMENT M.S. Thesis

John Anthony Skorupa Dec 1976 140 p refs
(AD-A034942, GAE/MC/76D-7) Avail NTIS HC A07/MF A01 CSCI 01/2

Main gear load vs time is predicted for an F-4E aircraft through the use of subsystem modeling and analog computation. Subsystems modeled are the aerodynamics, engine dynamics, vertical strut dynamics, fore-aft strut dynamics, tire/wheel dynamics, brake dynamics, and antiskid dynamics. The problem is restricted to a landing sequence with three degrees of freedom permitted for the aircraft. Aerodynamics are based on constant coefficients of lift, drag, and pitching moment. A drag chute is also employed. Engine dynamics are based on a linear thrust vs velocity schedule. The strut dynamics are modeled by a mass-spring-damper system. The tire/wheel dynamics subsystem applies Newton's Second Law to derive the wheel slip ratio and ground-tire coefficient of friction. Brake dynamics are based on a schedule of brake torque vs brake pressure. Antiskid dynamics model the Hytrol Mark II antiskid system. Stopping distances from simulation are compared to flight test data to verify the model. Results from the simulation agree with flight test data. A schedule of main gear load vs velocity is proposed as an alternative to current tire testing practice. Author (GRA)

R77-24106# Hughes Helicopters, Culver City, Calif DESIGN, FABRICATION, AND TESTING OF ADVANCED COMPOSITE AH-1G TAIL SECTION (TAIL BOOM/VERTICAL FIN). Final Report, Jul 1973 - Feb 1976

James F Needham Nov 1976 164 p refs Prepared in cooperation with Fiber Sci, Inc
(Contract DAAJ02-73-C-0079, DA Proj 1F2-63211-DB41) (AD-A034457, HH-76-50, USAAMRDL-TR-76-2421) Avail NTIS HC A08/MF A01 CSCI 01/3

The purpose of this program was to design and fabricate a primary structural component for a helicopter using advanced composite materials. The component selected was the tail boom and vertical fin of the AH-1G Cobra helicopter. The composite tail boom was required to meet the existing metal tail boom structural design and stiffness criteria, and to be interchangeable with the metal tail boom. Design objectives were to reduce the life cycle costs to minimize the parts count, and to lower the overall weight of the existing structure. The composite tail boom successfully met the design criteria and objectives and completed all the structural and flight tests. The composite tail boom structure is a semimonocoque configuration using a sandwich wall construction. The inner and outer skins are fabricated of Thornel 300 graphite filaments with an epoxy resin, and the sandwich core is Nomex honeycomb. The wet-filament-winding technique was used in the fabrication of the major components. This research and development program established that primary helicopter

components could be efficiently fabricated from composite materials. The resulting structure would have a higher fatigue strength and a lower life-cycle cost than the metal structure, and it would have an improved ballistic tolerance. Author (GRA)

N77-24107# Advisory Group for Aerospace Research and Development, Paris (France)

FLIGHT TEST TECHNIQUES

Apr 1977 415 p. In ENGLISH, partly in FRENCH. Conf Proc of the Flight Mechanics Panel Symp, Porz Wahn, W Germany, 11-14 Oct 1976 (AGARD-CP-223, ISBN-92-835-0194-2) Avail NTIS HC A18/MF A01

Techniques used in flight clearance of the basic air vehicles, including flight control systems, engines, engine-inlet systems, etc., and the externally carried weapons are described along with techniques used in weapon system development. Instrumentation systems and components, data transmission, data processing, airborne displays and computers, and real time flight test analysis and monitoring are among the topics discussed.

N77-24108# Air Force Flight Test Center, Edwards AFB, Calif
FLIGHT CONTROL SYSTEM STRUCTURAL RESONANCE AND LIMIT CYCLE TESTS

Paul W Kirsten. In AGARD Flight Test Tech Apr 1977 17 p

Avail NTIS HC A18/MF A01

Theory, testing, and results pertaining to limit cycle and structural resonance characteristics of aircraft flight control are presented. Methods for insuring that limit cycling and structural resonance do not occur unexpectedly during flight are suggested. Ground tests and inflight envelope expansion tests were used with success in the past to determine limit cycle and structural resonance characteristics. Data obtained from these tests are presented for several aircraft. Also, control system modifications made on several aircraft to eliminate control system instabilities which were uncovered through ground testing are included. Additional topics are discussed which include digital sampling effects on limit cycle characteristics, large amplitude saturation limit cycles, and pilot-in-the-loop instabilities. Author

N77-24109# Hawker Siddeley Aviation Ltd, Dunsfold (England)
FLIGHT TESTING TECHNIQUES, AUTUMN 1976

R J Poole. In AGARD Flight Test Tech Apr 1977 17 p

Avail NTIS HC A18/MF A01

A test program to demonstrate the aircraft's controllability in, and the recovery procedure from a spin formulated with reference to spinning tunnel tests is described. Data presented are gathered using the aircraft's PCM recording equipment and telemetered records observed by flight test engineers, together with the safety ground pilot, while the spins were being executed. This instrumentation together with the pilot displays and warnings in the cockpit are described. The recovery procedures to be adopted and the pilots' qualitative assessment of their effectiveness are included. Author

N77-24110# Office National d'Etudes et de Recherches Aeronautiques, Paris (France)

METHODS AND TECHNIQUES OF GROUND VIBRATION TESTING

Gerard Piazzoli. In AGARD Flight Test Tech Apr 1977 9 p refs. In FRENCH, ENGLISH summary

Avail NTIS HC A18/MF A01

Flight vibration tests, an important and sophisticated part of the aeroelastic research carried out for prototype clearance and certification of production aircraft, are described along with methods used for dynamic investigations of structural stability. The different techniques for delivering excitation forces, the special equipment of measurement and conditioning, and present methods of data processing and analysis are illustrated. Typical installations on aircraft of various types are described. Author

N77-24111# British Aircraft Corp, Preston (England) Military Aircraft Div

TORNADO FLIGHT LOADS SURVEY

D W Altham, D K Potter, J Nuscheler (Messerschmitt-Boelkow-Blohm GmbH, Munich), and W Seidel (Messerschmitt-Boelkow-Blohm GmbH, Munich). In AGARD Flight Test Tech Apr 1977 16 p refs

Avail NTIS HC A18/MF A01

Flight loads survey instrumentation and its calibration, data acquisition and analysis techniques, and a flight test program for the TORNADO aircraft are described. Several examples of test results are given and discussed. Author

N77-24112# British Aircraft Corp, Preston (England) Military Aircraft Div

THE EFFECT OF A COMMAND AND STABILITY AUGMENTATION SYSTEM ON FLIGHT TESTING

T B Saunders. In AGARD Flight Test Tech Apr 1977 16 p refs

Avail NTIS HC A18/MF A01

The influence of a CSAS on flight test procedures, analysis techniques, and instrumentation requirements is discussed and is shown to be a significant factor in promoting developments in these three areas. Current handling qualities criteria are considered in relation to the CSAS. Some handling qualities requirements are written in terms that cover the introduction of major new concepts like the CSAS. Author

N77-24113# Aeronautical Systems Div, Wright-Patterson AFB, Ohio

DEVELOPMENT FLIGHT TEST TECHNIQUES FOR DIGITAL MULTIMODE FLIGHT CONTROL SYSTEMS

David L Carleton. In AGARD Flight Test Tech Apr 1977 14 p refs

Avail NTIS HC A18/MF A01

A technique that assesses the aircrafts' ability to allow the pilot to perform precision tracking tasks such as air to air gunnery and air to ground weapon delivery is described. Data requirements, evaluation criteria and examples of how the technique is used in flight test programs are included along with a discussion of merits and limitations of the technique. Author

N77-24114# British Aircraft Corp (Operating) Ltd, Bristol (England) Commercial Aircraft Div

FLIGHT ASSESSMENT AND DEVELOPMENT OF THE CONCORDE INTAKE SYSTEM

D P Morris. In AGARD Flight Test Tech Apr 1977 42 p

Avail NTIS HC A18/MF A01

The rapid exposure and resolution of problems were the prime objectives of the flight investigation program devised to exploit fully the advantage of preflight prediction of potential problem areas. An account of the flight investigation, including a description of the test techniques employed, is placed in perspective by a brief recapitulation of the design of the engine air inlet system and the associated fundamental control concepts. The impact of flight investigation on the evolution of the certification standard aircraft is apparent, e.g., modification of the prototype standard wing leading edge to improve surge-free negative incremental normal acceleration capability, and suppression of local reference pressure sensing for automatic air inlet control in favor of computed reference signals derived from central air data sources. In similar context the clear emergence of the necessity to place reliance on flight test data as the basis of formulation of the production standard air inlet control system functional laws is of paramount significance. Flight determination of the sensitivity of engine surge thresholds and hence the effective maneuver, Mach Number, and throttling limits to systematic variation of inlet geometry proved to be essential. The delicate balance between the requirements of performance, inlet/engine compatibility, and simplicity of crew management, dictated by considerations of commercial viability, was achieved by the air inlet control system laws so derived. Author

N77-24115# Royal Aircraft Establishment Farnborough (England)

WEAPONS TESTING TECHNIQUES

F J Bigg, N Tait (Cape Engineering Ltd., Warwick, Eng) and D A Williams (Cranfield Inst of Technology) *In* AGARD Flight Test Tech Apr 1977 13 p refs

Avail NTIS HC A18/MF A01

The philosophy adopted by the Directorate of Air Armament MOD (PE) United Kingdom and the Air Armaments Department Royal Aircraft Establishment Farnborough in obtaining experimental information relevant to the design and clearance of free fall weapons and associated carriage equipment is described. A number of instrumented stores which were developed as a result are described in some detail, and the conclusions are presented.

Author

N77-24116# National Gas Turbine Establishment Pyestock (England)

SUPERSONIC POWERPLANT TESTING FOR PREFLIGHT PERFORMANCE EVALUATION

G G Annear *In* AGARD Flight Test Tech Apr 1977 12 p refs

Avail NTIS HC A18/MF A01

The facilities used to evaluate the performance at supersonic speeds of complete propulsion units, (inlet engine and exhaust system) is described. The way in which ground level test bed data are used to predict flight performance, and how the prediction may be refined by the use of altitude Cell data are discussed.

Author

N77-24118# Technische Hogeschool, Delft (Netherlands) Dept of Aerospace Engineering

ESTIMATION OF DRAG AND THRUST OF JET-PROPELLED AIRCRAFT BY NON-STEADY FLIGHT TEST MANEUVERS

J A Mulder and J M VanSliedregt *In* AGARD Flight Test Tech Apr 1977 30 p refs

Avail NTIS HC A18/MF A01

When measuring aircraft performance or lift-drag characteristics in steady or nonsteady flight numerical apriori information is required from engine (altitude) test facilities for an accurate determination of engine thrust. It is shown that this need for apriori information may be eliminated by an inflight calibration of the measuring probes for engines gross thrust and mass flow simultaneously with the measurement of the aircraft lift-drag characteristics. Results are presented of 9 nonsteady flight test maneuvers with a Hawker Hunter mk VII jet aircraft at 10 000, 20 000, and 30 000 ft nominal flight altitude. Besides lift-drag characteristics and engine gross thrust and mass flow calibration factors, several alternative performance characteristics as excess thrust in horizontal flight and also stability and control characteristics may be deduced from the measurements. The validity of the flight test results, in particular with respect to the inflight calibration of the gross thrust and mass flow measuring probes is, because of the particular aircraft exploited for the flight tests, restricted to the case of a so-called straight jet engine configuration and a non-flexible aircraft.

Author

N77-24119# Dornier-Werke G m b H Friedrichshafen (West Germany)

FLIGHT TESTING AND EVALUATION TECHNIQUES FOR THE DETERMINATION OF HANDLING QUALITIES

Horst Wuennenberg and Ulrich VonMeier *In* AGARD Flight Test Tech Apr 1977 13 p refs

Avail NTIS HC A18/MF A01

The techniques of handling qualities determination in flight testing are discussed. The main targets for flight testing are described and examples from the Alpha Jet flight testing are presented. It is proposed to present the necessary information for flight manual and certification documentation (pilot comments, flight test evaluation, and theoretical calculations) in table form.

Author

N77-24120# Air Force Flight Test Center, Edwards AFB, Calif
A MISSION ORIENTED FLIGHT TEST TECHNIQUE FOR IDENTIFYING AIRCRAFT AND FLIGHT CONTROL SYSTEM TRANSFER FUNCTIONS

Thomas R Twisdale, Gerald L Jones and Tice A Ashurst *In* AGARD Flight Test Tech Apr 1977 14 p refs

Avail NTIS HC A18/MF A01

Data analysis techniques were developed at the Air Force Flight Test Center (AFFTC) which offer unique and quantitative insights into pilot-in-the-loop handling qualities. These data analysis techniques called System Identification From Tracking (SIFT), are based on time series analysis procedures. These procedures are used to perform a frequency domain evaluation of data obtained during closed-loop mission oriented precision tracking maneuvers. Normal stability and control test parameters are measured and recorded in the time domain during the maneuver. As many as four of these parameters are selected as multiple inputs to the system being evaluated and one parameter is selected as the system response. These time domain data are Fourier transformed into the frequency domain, where spectral content, multiple frequency response transfer functions, and coherence functions are estimated and plotted. Depending on the parameters selected for analysis, either the flight control system (or its components), or the airframe aerodynamics, or the total system characteristics (control system plus aerodynamics) may be identified. Interim results show that, for the aircraft being analyzed, lateral-directional coupling into the pitch axis has an unexpected and apparently significant impact on longitudinal handling qualities even for small angles of attack and sideslip.

Author

N77-24121# Air Force Flight Test Center, Edwards AFB, Calif
Systems Engineering Branch

OVERALL AIRCRAFT SYSTEMS EVALUATION

Frank N Lucero and Charles E Adolph *In* AGARD Flight Test Tech Apr 1977 13 p

Avail NTIS HC A18/MF A01

The managerial and test procedures used by personnel at the Air Force Flight Test Center to plan, conduct, and report on overall aircraft systems test programs are described.

Author

N77-24122# National Aerospace Lab., Amsterdam (Netherlands)
DETERMINATION OF ANTENNA RADIATION PATTERNS, RADAR CROSS SECTIONS AND JAM-TO-SIGNAL RATIOS BY FLIGHT TESTS

O B M Pietersen, G J Alders, and R B A Wasch *In* AGARD Flight Test Tech Apr 1977 6 p

Avail NTIS HC A18/MF A01

A data acquisition and processing method aimed at the determination of radiation patterns of airborne equipment is described. The data acquisition procedure and more specific, the data processing and presentation schemes used are emphasized.

Author

N77-24123# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst Fuer Flugfuehrung

REAL TIME DATA TRANSMISSION AND PROCESSING FOR THE DETERMINATION OF AIRCRAFT ANTENNA RADIATION PATTERNS

Helmut Bothe *In* AGARD Flight Test Tech Apr 1977 11 p refs

Avail NTIS HC A18/MF A01

A measuring system determining aircraft antenna radiation patterns in flight is described. Measuring system requirements and configuration are outlined. Real time data processing and quick-look monitoring during flight tests are enabled by a telemetry system, the state of which is described.

Author

N77-24124# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst fuer Flugfuehrung

HYBRID REFERENCE SYSTEMS FOR FLIGHT TESTING

Heinz Winter and Ulrich Brokof / In AGARD Flight Test Tech
Apr 1977 15 p refs

Avail NTIS HC A18/MF A01

Hybrid reference systems consisting of ground-based measuring equipment (tracking radar, long distance radar) and on-board sensors (Doppler or inertial navigation systems) were analyzed with respect to the accuracy of position, velocity, and attitude measurement. Flight experiments demonstrated that the high accuracies required for weapon guidance systems testing can be obtained with such systems. Author

R77-24126# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst fuer Flugfuehrung

FLIGHT TESTING OF DISPLAYS IN A HELICOPTER

R Beyer / In AGARD Flight Test Tech Apr 1977 11 p refs

Avail NTIS HC A18/MF A01

Electro-optical sensors and electronic displays for a future helicopter avionics system may extend the flexibility of helicopter operation at night and in bad weather. Flight tests were made with a simulated system which presented a combination of flight instruments and an image of the terrain to the pilot. Means were developed to assess flight performance and pilot strain in flights with the system and some of the measures and the results obtained are discussed. Author

R77-24128# Royal Aircraft Establishment, Farnborough (England) Dept of Instrumentation and Trials

ANGULAR MOTION SENSING WITH GAS ROTORS

W R MacDonald / In AGARD Flight Test Tech Apr 1977 26 p refs

Avail NTIS HC A18/MF A01

Angular motion transducers based on a gas rotor are discussed. These exploit the fact that when a coil of tube containing gas experiences angular acceleration, a pressure proportional to the acceleration is generated. The pressure is measured by a capacitive membrane sensor and depending on the design characteristics, outputs representing angular acceleration, vibratory angular displacement, or vibratory angular velocity may be obtained. The design and performance of these three types of transducer are discussed in detail and examples of practical instruments are given. Gas rotor transducers display characteristics similar to those of rotary spring-mass systems, but they are effectively devoid of moving parts and in principle are perfectly balanced. They are therefore potentially cheap and very robust. Moreover, since the rotor can be of any convenient shape, optimum use can be made of available space and multi-axis instruments of similar size to their single-axis counterparts are feasible. Author

R77-24127# Centre d'Essais en Vol, Istres (France)

EXAMPLES OF LASER UTILIZATION IN CIVIL AIRCRAFT CERTIFICATION TESTS

Nicolas Lapchine / In AGARD Flight Test Tech Apr 1977 20 p refs In FRENCH

Avail NTIS HC A18/MF A01

The STRADA system installed at the Brittany Flight Test Center was used in flight certification tests of the Concorde and Mercure 100 aircraft. The system uses optical radar (LIDAR) mounted on a turret, consisting of a yttrium-aluminum yag laser transmitting in the infrared at a frequency of 3200 impulses per second. The luminous energy received by passive retroreflectors mounted on the aircraft is received in an optical reception system linked to two receivers which measure distance and angle variations. A computer is used for real time calculation of the trajectory of the reflectors mounted on the aircraft. Tests for both the Concorde and the Mercure flights are described. Transl by A R H

R77-24133# Systems Control, Inc., Palo Alto, Calif
CIVIL MINI-RPA'S FOR THE 1980'S AVIONICS DESIGN CONSIDERATIONS Final Report, Jan. - Jun 1975

J S Karmarkar Jul 1975 63 p refs

(Contract NAS2-7747)

(NASA-CR-127679) Avail NTIS HC A04/MF A01 CSCL 01D

A number of remote sensing or surveillance tasks (e.g., fire fighting, crop monitoring) in the civilian sector of our society may be performed in a cost effective manner by use of small remotely piloted aircraft (RPA). This study was conducted to determine equipment (and the associated technology) that is available, and that could be applied to the mini-RPA and to examine the potential applications of the mini-RPA with special emphasis on the wild fire surveillance mission. The operational considerations of using the mini-RPA as affected by government regulatory agencies were investigated. These led to equipment requirements (e.g., infra-red sensors) over and above those for the performance of the mission. A computer technology survey and forecast was performed. Key subsystems were identified and a distributed microcomputer configuration, that was functionally modular was recommended. Areas for further NASA research and development activity were also identified. Author

R77-24134# Illinois Univ., Urbana-Champaign Savoy Aviation Research Lab

ADVANCED INTEGRATED AIRCRAFT DISPLAYS AND AUGMENTED FLIGHT CONTROL Final Scientific Report, 1973 - 1976

Stanley N Roscoe Nov 1976 42 p refs

(Contract N00014-76-C-0081)

(AD-A034817, ARL-76-17/ONR-76-4)

Avail NTIS

HC A03/MF A01 CSCL 01/4

The Aviation Research Laboratory of the University of Illinois has investigated integrated computer-generated symbolic displays and computer-augmented flight control for the Office of Naval Research. The research was directed toward (1) the isolation of minimum sets of visual image cues sufficient for spatial and geographic orientation in the various ground-referenced phases of representative flight missions, (2) the generation and spatially integrated presentation of computed guidance commands and fast-time flight path predictors, and (3) the matching of the dynamic temporal relationships among these display indications for compatibility with computer-augmented flight performance control dynamics, both within each ground-referenced mission phase and during transitions between phases. The investigative program drew selectively upon past work done principally under ONR sponsorship or partial sponsorship, including the ANIP and JANAIR programs. Author (GRA)

R77-24135# Army Electronics Command, Fort Monmouth, N J
DIGITAL GENERATION OF CONTOUR MAPS FOR RASTER SCAN DISPLAY

Victor Vajo Dec 1976 57 p

(DA Proj 1F2-62202-AH-85)

(AD-A034663, ECOM-4454) Avail NTIS CSCL 17/7

This report is concerned with the development of a digitally generated contour map to be displayed on standard raster TV for use in Army aircraft. The requirement for a display of this type is generated by the operations of Army aircraft in nap-of-the-earth (NOE) flight during both day and night operation. NOE flight in this case refers specifically to pilotage at or below tree top level. The study proved the feasibility of generating digital contour maps for display on standard TV monitors. Computer programs were written in assembly language for the Singer SKC-2000 Airborne Computer which generate two color (black and white) contour maps for display on a standard 525 line television system. GRA

R77-24136# Air Force Academy, Colo
HELMET MOUNTED DISPLAYS AS AN ALTERNATE SOURCE OF FLIGHT INFORMATION Final Report

Eugene H Gallusio, John E Rasinski, and Robert G Eggleston Jan 1977 32 p refs

(AD-A034724, USAFA-TR-77-1)

Avail NTIS

HC A03/MF A01 CSCL 01/2

The potential use of Helmet Mounted Displays (HMD) as an alternate source of flight information was examined. Air Force T-41 instructor pilots were trained to perform two complex

flight maneuvers in a GAT 1 flight simulator using a monocular visor-projected display as the sole source of aircraft flight information. A search pattern and weapons delivery maneuver were flown utilizing standard aircraft instruments. The pilot flew the maneuvers under four experimental conditions: (1) referencing the simulator instruments only, (2) referencing the simulator instruments with selected instruments occluded, (3) referencing the helmet display only, (4) referencing the helmet display with selected instruments occluded. GRA

N77-24137*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field, Calif
INTERIOR AND EXTERIOR FUSELAGE NOISE MEASURED ON NASA'S C-8A AUGMENTOR WING JET-STOL RESEARCH AIRCRAFT
Michael D Shovlin Apr 1977 50 p refs
(NASA-TM-X-73235, A-7012) Avail NTIS HC A03/MF A01 CSCL 20A

Interior and exterior fuselage noise levels were measured on NASA's C-8A Augmentor Wing Jet-STOL Research Aircraft in order to provide design information for the Quiet Short-Haul Research Aircraft (QSRA), which will use a modified C-8A fuselage. The noise field was mapped by 11 microphones located internally and externally in three areas: mid-fuselage, aft fuselage, and on the flight deck. Noise levels were recorded at four power settings varying from takeoff to flight idle and were plotted in one-third octave band spectra. The overall sound pressure levels of the external noise field were compared to previous tests and found to correlate well with engine primary thrust levels. Fuselage values were 145 + or - 3 dB over the aircraft's normal STOL operating range. Author

N77-24138*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
INLET REYNOLDS NUMBER AND TEMPERATURE EFFECTS ON THE STEADY-STATE PERFORMANCE OF A TFE731-2 TURBOFAN ENGINE
George A Bobula and Roy A Lottig Washington May 1977 51 p refs Prepared in cooperation with the US Army Air Mobility R and D Lab, Cleveland
(NASA-TM-X-3537, E-8941) Avail NTIS HC A04/MF A01 CSCL 21E

Effects of varying engine inlet Reynolds number index (0.75, 0.50, 0.25, and 0.12) and temperature (289 and 244 K) on a TFE731-2 turbofan engine were evaluated. Results were classified as either compression system effects or effects on overall performance. Standard performance maps are used to present compression system performance. Overall performance parameters are presented as a function of low rotor speed corrected to engine inlet temperature. Author

N77-24139*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
ANALYTICAL PREDICTION OF THE PERFORMANCE AND STABILITY OF A J85-13 COMPRESSOR WITH DISTORTED INLET FLOW
Edward J Milner Washington May 1977 31 p refs
(NASA-TM-X-3515, E-8887) Avail NTIS HC A03/MF A01 CSCL 21E

The parallel compressor concept was studied using a compressor model based on the overall clean-inlet performance map obtained from experimental tests in an altitude chamber using a General Electric J85-13 turbojet engine. The model, which includes a static-pressure balance calculation at compressor discharge, was exercised at conditions corresponding to 10 different screen-induced distortion patterns included in the experimental data base. The spoiled area of these patterns ranged from 30 deg to 180 deg, and the distortion screen density, or the area blocked by the screen wire per unit area of screen, varied from 26 to 69 percent. The study indicates that at the higher corrected speeds, the analytical surge lines obtained are good representations of the corresponding experimental surge lines and are independent of distortion angle or distortion angle or distortion level. Author

N77-24140*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
PERFORMANCE OF HIGH-AREA-RATIO ANNULAR DUMP DIFFUSER USING SUCTION-STABILIZED-VORTEX FLOW CONTROL

Albert J Juhasz and John M Smith Washington May 1977 41 p refs
(NASA-TM-X-3535, E-9011) Avail NTIS HC A03/MF A01 CSCL 21E

A short annular dump diffuser having a geometry conducive to formation of suction stabilized toroidal vortices in the region of abrupt area change was tested. The overall diffuser area ratio was 4.0 and the length to inlet height ratio was 2.0. Performance data were obtained at near ambient temperature and pressure for inlet Mach numbers of 0.18 and 0.30 with suction rates ranging from 0 to 18 percent of total inlet mass flowrate. Results show that the exit velocity profile could be readily biased toward either wall by adjustment of inner and outer wall suction rates. Symmetric exit velocity profiles were inherently unstable with a tendency to revert to a hub or tip bias. Diffuser effectiveness was increased from about 38 percent without suction to over 85 percent at a total suction rate of 10 to 12 percent. At the same time diffuser total pressure loss was reduced from 3.1 percent to 1.1 percent at an inlet Mach number of 0.3. Author

N77-24141*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
NOISE OF FAN DESIGNED TO REDUCE STATOR LIFT FLUCTUATIONS

James H Dittmar, Richard P Woodward, and Edward G Stakolich Washington May 1977 47 p refs
(NASA-TM-X-3538, E-8986) Avail NTIS HC A03/MF A01 CSCL 20A

An existing fan stage was redesigned to reduce stator lift fluctuations and was acoustically tested at three nozzle sizes for reduced noise generation. The lift fluctuations on the stator were reduced by increasing the stator cord, adjusting incidence angles, and adjusting the rotor velocity diagrams. Broadband noise levels were significantly reduced in the middle to high frequencies. Blade passage tone sound power was not lessened, but decreases in the harmonics were observed. Aerodynamic improvements in both performance and efficiency were obtained. Author

N77-24142# European Space Agency, Paris (France)
INFLUENCE OF LEADING EDGE RADIUS ON THE PERFORMANCE OF HIGHLY DEFLECTED STATOR CASCADES

J Paulon Mar 1977 22 p refs Transl into ENGLISH from Assoc Tech Maritime et Aeron, Bull no 73, 1973 p 485-503 Original report in FRENCH previously announced as 74A19686 (ESA-TT-362, ONERA-TP-1237) Avail NTIS HC A02/MF A01

An experimental facility, which includes an inducer producing swirl in the flow in an annular channel between two coaxial cylinders, was used to study axial compressor stator blade profiles. These form a fixed annular cascade and the performances in compression, deflection, and efficiency are measured at the mid-radius. This facility is very flexible in operation since, by varying the supply total pressure, it allows a wide range of Mach numbers to be investigated between 0.30 and 0.80 (0.80 corresponds closely to the choking of the cascade studied). Furthermore, the angle of attack, and hence the incidence, can be varied over a range of about 12 deg by changing the inducer (5 inducers are used). The performances obtained with this cascade show that off-design losses are governed by the leading-edge radius which is thus seen to be an important parameter. Tests performed with the same blades, given a progressively rounded leading edge, show that although the performances in compression ratio and total pressure recovery remain practically unaffected near the design condition, a small leading-edge radius improves the deflection performance. A simple empirical formula correlating the experimental results is given which allows a grouped arrangement of the losses obtained. This might be useful in research to find an optimum stator as a function of the Mach number and the incidence. Author (ESA)

N77-24143# Pratt and Whitney Aircraft Group, West Palm Beach, Fla Government Products Div
F100 MULTIVARIABLE CONTROL SYSTEM ENGINE MODELS/DESIGN CRITERIA Final Report, 1 Jun 1976 - 31 Aug 1976

Ronald J Miller and Ronald D Hackney Nov 1976 135 p refs

(Contract F33615-75-C-2048, AF Proj 3066)

(AD-A033532, FR-7809, AFAPL-TR-76-74) Avail NTIS HC A07/MF A01 CSCL 21/5

The objective of the F100 multivariable Control research program is to extend the linear quadratic regulator (LQR) theory to develop a 'practical' control system that can operate a state-of-the-art gas turbine engine over its entire flight envelope. The engine selected for this program is a Pratt and Whitney Aircraft F100 afterburning turbofan. To determine the adequacy of the control synthesis effort, the resulting control logic will be incorporated into a digital computer/controller, which then will be used to control a F100 engine in an altitude test facility at NASA Lewis Research Center. The F100 engine computer simulations, the control criteria for defining the basic requirements of a F100 control system, and a brief evaluation of the resulting LQR engine control system are presented in this report. GRA

N77-24144# Purdue Univ., Lafayette, Ind School of Aeronautics and Astronautics

WATER INGESTION INTO AXIAL FLOW COMPRESSORS Final Report, 1 Apr 1975 - 31 Aug 1976

S N Murthy, B A Reese, C L Abernathy, and G T Arcangeli Wright-Patterson AFB, Ohio AFAPL Aug 1976 128 p refs (Contract F33615-74-C-2014)

(AD-A033611, M-WPAFB-T-76-1, AFAPL-TR-76-77) Avail NTIS HC A07/MF A01 CSCL 21/5

The problem of the flow of a gas-liquid mixture through a multi-stage axial compressor originally designed for air flow arises during take-off from a rough runway with water on it and during rain. Preliminary investigations have revealed the problem areas in the fan, LP, and HP compressor stages. The basic aerothermodynamic equations have been deduced in a form suitable for considering development of a computational program.

Author (GRA)

N77-24145# ARO, Inc., Arnold Air Force Station, Tenn
EVALUATION OF AN AIRJET DISTORTION GENERATOR USED TO PRODUCE STEADY-STATE, TOTAL-PRESSURE DISTORTION AT THE INLET OF TURBINE ENGINES Final Report, 13 Oct 1975 - 4 Feb. 1976

B W Overall AEDC Dec 1976 82 p refs Sponsored by Air Force

(AD-A033883, ARO-ETF-TR-76-91, AEDC-TR-76-141) Avail NTIS HC A05/MF A01 CSCL 21/5

A performance evaluation of an airjet distortion generator system used to produce steady-state, total-pressure distortion at the inlet to a turbine engine was conducted. The capability of the system to duplicate screen-generated, parametric distortion patterns (180 deg, one per revolution, tip radial, hub radial) and to maintain a constant composite distortion pattern over a range of airflows is presented. A comparison of the effect of inlet distortion produced by screens to that produced by the airjet distortion generator system on the stability characteristics of a present-day turbofan engine is described. Author (GRA)

N77-24146# Defense Systems Management School, Fort Belvoir, Va

IMPROVING JET ENGINE RELIABILITY AND MAINTAINABILITY A CONCEPTUAL APPROACH

John D Masson 5 May 1976 47 p refs

(DSMS Proj PMC-76-1)

(AD-A033815) Avail NTIS HC A03/MF A01 CSCL 21/5

The purpose of this report is to propose a management approach to be used to improve jet engine reliability and maintainability. The need for improvement is established through

an examination of the life cycle of an engine, the estimated costs, costs associated with each life cycle phase, and the factors occurring during each phase that significantly affect reliability and maintainability. This review concludes that significant changes to the engine development and acquisition changes are not practical. The proposed approach is intended for use within the existing engine life cycle framework. GRA

N77-24148# European Space Agency, Paris (France)
STABILIZATION, GUST ALLEVIATION AND ELASTIC MODE CONTROL FOR AN AIRCRAFT MODEL MOVING IN THE WIND TUNNEL

Gernot Hoffmann Apr 1977 150 p refs Transl into ENGLISH of 'Stabilisierung, Boenkompensation u Schwingungsdaempfung am elastischen, beweglichen Flugzeugmodell im Windkanal', DFVLR, Brunswick Report DLR-FB-76-44, DFVLR, Brunswick Report DLR-FB-76-44, 11 Aug 1976. Original report in GERMAN previously announced as N77-17104. Original German report available from DFVLR, Cologne DM 49 60

(ESA-TT-359, DLR-FB-76-44) Avail NTIS HC A07/MF A01

For an elastic aircraft model which can move in the wind tunnel with several degrees of freedom, the development and practical test of a multivariable controller is discussed. The controller stabilizes the elevation and the pitch angle, alleviates vertical gusts, and improves the damping of the first elastic mode. The control system synthesis depends on principles of optimization and simulation in the state space. Some low order linear filters are needed to meet the technical conditions.

Author (ESA)

N77-24149# Laboratorium fuer Betriebsfestigkeit, Darmstadt (West Germany)

COMPARISON OF SEVERAL MODELS DESCRIBING THE GUST LOADS ON AIRCRAFT STRUCTURES

O Buxbaum and J M Zschel 1976 50 p refs In GERMAN ENGLISH summary Sponsored by Bundesmin fuer Verkehr (LBF-TB-130/76) Avail NTIS HC A03/MF A01

Two gust models and their application in airworthiness regulations are described. Their suitability in determining static and fatigue strength of aircraft structures was investigated. The models considered were discrete gust model based on a sequence of single isolated gusts and a model of continuous turbulence accounting for turbulence as a stochastic process. The model of continuous turbulence was shown to improve the description of gust loads and the prediction of dynamic response, presuming that the statistical distribution of gust velocities and the transfer function of the aircraft under consideration are known. ESA

N77-24150# Army Cold Regions Research and Engineering Lab Hanover, N H

AIR CUSHION VEHICLE GROUND CONTACT DIRECTIONAL CONTROL DEVICES Special Report

Gunars Abele and Ronald A Liston Dec 1976 25 p refs

(DA Proj 4A1-61101-A-91D)

(AD-A034825, CRREL-SR-76-45) Avail NTIS HC A02/MF A01 CSCL 01/3

The maneuverability of air cushion vehicles can become a serious operational problem when the vehicle's travel route is restricted by obstacles, slopes or cross-wind conditions, or when close-quarter turns are required. While improvement and perfection of aerodynamic methods may be a more desirable approach, there is a practical limit to these methods, and the use of ground contact devices requires consideration for providing more positive directional control. Wheels deserve special attention, and therefore are analyzed in more detail because of their obvious application on a variety of land terrains. Brake rods and harrows are more suitable on water, ice and snow. The saucer-shaped ground contact device would cause the least ecological impact on fragile organic terrains such as tundra. Relative directional stability is evaluated in terms of the total yawing moments produced by wheel arrangements (single, dual, tandem), location on the vehicle, and operational modes (free-rolling, braked, or a combination of the two). The available moments are plotted against the yaw angle of the vehicle to determine the most effective operational mode with a particular wheel arrangement for any yaw condition. The analysis is limited to retractable devices which act as moment

producing brakes or rollers and do not serve as either propulsion or load support aids. Controlled ground contact with skirt sections having special wearing surfaces may provide a suitable control method and would require the least significant change to the basic design of the vehicle or its components. The concept involves the use of an air flow control mechanism for deflating specific skirt sections. GRA

N77-24151# General Dynamics Corp., San Diego, Calif. Convair Aerospace Div
CONTROL POWER CRITERIA FOR STATICALLY UNSTABLE AIRCRAFT Final Report
 Nov 1976 71 p
 (Contract N00019-75-C-0355)
 (AD-A033969, CASD-NSC-76-003) Avail NTIS
 HC A04/MF A01 CSCL 01/3

The sensitivity of control power requirements during gust response to variations in aircraft parameters and input disturbance levels has been investigated in an attempt to provide data useful in establishing design criteria and margins of safety needed in the control of aerodynamically unstable aircraft. Both canard configured and a conventional tail configured aircraft were used in this study. For both configurations the critical flight conditions were during the low-speed power approach. The critical gust frequency in terms of critical power requirement for a (1-cos) type gust was approximately twice the closed loop natural frequency of the aircraft. Static margin was found to be the primary quantity influencing the control power requirements. The sensitivity of required control power to variation in other aircraft parameters is predictable by the manner in which these parametric variations alter the static margin. The high angle of attack characteristics also had a significant effect on the control power requirements - indicating the need for a complete and accurate data base in this region. The gust upset boundaries dropped off sharply when the discrete gust was applied at a significant angle from the vertical. The control power requirements were found to be relatively insensitive to variations in the discrete gust mode shape in the absence of control surface rate saturation. Likewise, the increases in required control power due to increased gust magnitude were also relatively small when the surfaces were not rate saturated. When rate limits were reached, however, discrete gust magnitude and shape became more significant and those gust shapes that caused the longest periods of rate saturation were most critical. GRA

N77-24154# Army Engineer Waterways Experiment Station, Vicksburg, Miss
USAGE OF LANDING MAT AS OVERLAY ON ASPHALT RUNWAY DURING MILITARY FIELD EXERCISES Final Report
 Hugh L Green Dec 1976 77 p refs
 (AD-A033914, WES-MP-S-76-24) Avail NTIS
 HC A05/MF A01 CSCL 01/5

This report describes four military exercises conducted at Oak Grove, N C., in which XM18 landing mat was placed over a deteriorating asphalt runway to provide a landing strip for C-130 cargo aircraft. In the past, studies had been conducted at the WES on this subject, however, this was the first opportunity to gain firsthand knowledge on the behavior of the aircraft and the landing mat during a field exercise. This report is based on Memorandums for Record (MFR's) prepared for each of the exercises, which were conducted over a four-year period. Details of each exercise are described in the MFR's, which are presented in their entirety as appendices in this report. The lessons learned that may be helpful in future installations of landing mat over asphalt are listed in the form of conclusions and recommendations. This report should prove to be a valuable aid to a unit commander responsible for installation of landing mat over asphalt pavement. GRA

N77-24155# Calspan Corp., Buffalo, NY
INTERFERENCE-FREE WIND-TUNNEL FLOWS BY ADAPTIVE-WALL TECHNOLOGY
 W R Sears, R J Vidal, J C Erickson, Jr., and A Ritter Jan 1977 25 p refs Presented at the 10th Congr of the Intern

Council of the Aeron Sci., Ottawa, 3-8 Oct 1976
 (Contracts N00014-77-C-0052, N00014-72-C-0102)
 (AD-A034889, CALSPAN-RK-6040-A-1, ICAS-Paper-76-02)
 Avail NTIS HC A02/MF A01 CSCL 14/2

The adaptive-wall or self-correcting wind tunnel has been proposed for such regimes as transonic and V/STOL where wall effects are large and cannot be corrected. The power and generality of the concept are pointed out. In a two-dimensional transonic embodiment in the Calspan One-Foot Tunnel, the scheme has been shown to work at lower transonic Mach numbers. Several practical problems are cited including instrumentation, the nature of the wall modification, and convergence of the iterative procedure. Moreover, questions of shock-wave neutralization at the wall and probable configuration of three-dimensional embodiments are discussed. GRA

N77-24156# Army Aviation Center, Fort Rucker, Ala
COST AND TRAINING EFFECTIVENESS ANALYSIS (CTEA) OF THE CH-47 FLIGHT SIMULATOR (CH47FS)
 3 Dec 1976 48 p refs

(AD-A033972) Avail NTIS HC A03/MF A01 CSCL 14/2
 The CH47FS CTEA Study Plan presents the purpose of the study and the terms of reference including the problem statement, the objectives, scope, limits and assumptions, and the Essential Elements of Analysis (EEA). The alternative training packages selected for analysis and the Measures of Training Effectiveness (MOTEs) are defined. The support and resource requirements for the study are listed and control procedures and the study schedule established. Included are also the methodology for analyzing training effectiveness, the operational test plan for generating effectiveness data, and the methodology for cost analysis. Author (GRA)

N77-24157# Air Force Avionics Lab., Wright-Patterson AFB, Ohio
VIDEO GENERATION AND CONTROL SYSTEM Final Report, Jul. 1975 - Jun. 1976
 Derryl A Williams Aug 1976 100 p
 (AF Proj 2003)
 (AD-A033853, AFAL-TR-76-164) Avail NTIS
 HC A05/MF A01 CSCL 14/2

The purpose of the Video Control Center is to generate, control, monitor, and record all standard video signals needed in AFAL/AA's simulation facility. Video signals may be generated live, from video tape, or from movie film. The video signals can be monitored at the console and distributed to a remote location such as the cockpit simulator. Special effects can be used to alter the signal. Cameras are available to observe the pilot's movements during a simulation. This information, as well as all other video signals, can be recorded on tape for future reference. The system can also serve as a training tool in that demonstration and instruction tapes can be produced. For example, the operation of the DAIS computer was demonstrated and recorded using the Video Control facility. The Flying Spot Scanner is designed to simulate a raster type sensor on an aircraft. The scanner is included in this report because it is a source of video and depends on control signals from the Video Control Center for operation. This report is a description of the Video Control Center and the Flying Spot Scanner. GRA

N77-24158# ARO, Inc., Arnold Air Force Station, Tenn
ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF EJECTOR-POWERED ENGINE SIMULATORS FOR WIND TUNNEL MODELS Final Report, 30 Jan. - 30 Jun 1976
 G D Smith, R J Matz, and R C Bauer AEDC Jan 1977 89 p refs Sponsored by the Air Force
 (ARO Proj RF-432, ARO Proj R32P-92A)
 (AD-A034725, ARO-ETF-TR-76-81, AEDC-TR-76-128) Avail NTIS HC A05/MF A01 CSCL 01/2

Ejector-powered engine simulators (EPES) that produce representative engine inlet and exhaust effects in wind tunnel models are currently under investigation at the Arnold Engineering Development Center (AEDC). Studies summarized in this report include theoretical and experimental investigations of single-stage, cold-flow EPES and theoretical investigations of two-stage,

cold-flow EPES and of single-stage EPES driven with heated jets. Existing AEDC jet pump and ejector-diffuser analytical models were used to predict EPES exhaust-to-inlet total pressure ratio inlet airflow, and velocity distributions during the jet mixing process. GRA

N77-24159# Springfield Municipal Airport Board, Mo
COMPREHENSIVE PLAN AND DEVELOPMENT PROGRAM FOR A REGIONAL INDUSTRIAL AIRPARK, SPRINGFIELD MUNICIPAL AIRPORT FOR THE CITY OF SPRINGFIELD, MISSOURI

Dec 1976 128 p Prepared in cooperation with Thompson (Arnold) and Assoc., Inc., Chicago and Isbill Assoc. Inc., Denver (Grant EDA-05-06-01565) (PB-262474/0, EDA-77-011) Avail NTIS HC A07/MF A01 CSCL 05C

The planning process for the regional industrial airpark to complement the Springfield Municipal Airport development is described. Several types of land uses were evaluated in proposing a recommended plan of implementation. GRA

N77-24169*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
DYNAMIC STABILITY CHARACTERISTICS OF THE COMBINATION SPACE SHUTTLE ORBITER AND FERRY VEHICLE

Delma C Freeman, Jr and Richmond P Boyden Washington May 1977 115 p refs (NASA-TM-X-3497, L-11131) Avail NTIS HC A06/MF A01 CSCL 22B

Subsonic forced-oscillation tests of a 0.015 scale model of the space shuttle orbiter/747 ferry vehicle were conducted in the Langley high speed 7- by 10-foot tunnel at Mach numbers of 0.2, 0.4, and 0.5 for angles of attack up to 12 deg. Tests were made of the basic 747 airplane, of the modified 747 (tip fins and struts added), of the ferry configuration, (747 plus orbiter at an incidence angle of 3 deg), and of the approach and landing test configuration (747 plus orbiter at an incidence angle of 6 deg). Author-

N77-24199*# Lockheed-California Co., Burbank
FLIGHT SERVICE EVALUATION OF KEVLAR-49/EPOXY COMPOSITE PANELS IN WIDE-BODIED COMMERCIAL TRANSPORT AIRCRAFT Annual Report

R H Stone Mar 1977 42 p refs (Contract NAS1-11621) (NASA-CR-145141, AR-3) Avail NTIS HC A03/MF A01 CSCL 11D

Kevlar-49 fairing panels, installed as flight service components on three L-1011s, were inspected after three years service, and found to be performing satisfactorily. There are six Kevlar-49 panels on each aircraft, including sandwich and solid laminate wing-body panels, and 150 C service aft engine fairings. The service history to date indicates that Kevlar-49 epoxy composite materials have satisfactory service characteristics for use in aircraft secondary structure. Author

N77-24204# Naval Air Development Center, Warminster, Pa Dept of Air Vehicle Technology
RESEARCH ON METAL MATRIX COMPOSITES FOR NAVAL AIRCRAFT ENGINES Progress Report, 1 Nov. 1971 - 31 Oct. 1976

Marshall K Thomas 25 Aug 1976 65 p refs (WRO2204001) (AD-A033724, NADC-76217-30, PR-2) Avail NTIS HC A04/MF A01 CSCL 21/5

Directionally solidified ingots of binary titanium base eutectics with iron, cobalt, and nickel have been analyzed metallographically and tested in tension. Of these alloys, the one having a titanium matrix with 40 percent volume fraction TiFe fibers appears to have the most promising morphology. Metallographic studies of arc melted buttons of columbium base binary, ternary, and quaternary alloys indicate several eutectic alloy systems with a potential for structural applications. A study of a Cr-25Cb-34Al (wt percent) directionally solidified alloy has verified the presence

of a eutectic at the composition predicted by the computer model of Kaufman and Nesor. Preliminary weight gain oxidation tests at 2200 F indicate the Cr-25Cb-34Al eutectic in the directionally solidified condition is superior in oxidation resistance to the carbide reinforced and directionally solidified eutectics currently being developed. GRA

N77-24287*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
CROSSLINKING AND DEGRADATION MECHANISMS IN MODEL SEALANT CANDIDATES Annual Report, 15 Sep. 1974 - 22 Apr 1977

K L Paciorek, J Kaufman, T I Ito, J H Nakahara, and R H Kratz Apr 1977 40 p refs (Contract NAS2-7981) (NASA-CR-151998, SN-8249-A2, AR-2) Avail NTIS HC A03/MF A01 CSCL 11A

Model compounds were studied to determine which type of heterocyclic ring is most advantageous for curing sealants based on perfluoroalkylether chains. The synthesis of specifically substituted materials and the evaluation of their stabilities in air, inert atmosphere, water, and Jet-A fuel at 235 and 325 C were investigated. Three heterocyclic ring systems were considered, namely, triazine, 1,2,4- and 1,3,4-oxadiazoles. Evaluations are given for the 1,3,4-oxadiazole system and the perfluoroalkylether substituted-1,2,4-isomer. The effect of Jet-A and water on perfluoroalkyl-1,2,4-oxadiazole and perfluoroalkylether triazine is determined. Author

N77-24336# Institute for Telecommunication Sciences, Boulder, Colo
RADAR MICROWAVE LINK PILOT SYSTEM UPGRADE AND EVALUATION Final Report

D Smith and F G Kimmitt Dec 1976 66 p (Contract DOT-FA74WA-1522) (AD-A037198, FAA-RD-76-184) Avail NTIS HC A04/MF A01 CSCL 17/2

Methods of upgrading the existing Radar Microwave Link systems were developed and tested in the laboratory. Replacement of existing Klystron and other tube-type components with solid-state units can be expected to provide additional system fade margin and greater system equipment reliability. Author

N77-24372# Signatron, Inc., Lexington, Mass
A SIMULATOR TO PRODUCE NARROWBAND MULTIPATH EFFECTS ON L-BAND AIRCRAFT-TO-SATELLITE SIGNALS Final Report, Mar 1972 - Jun. 1973

Edward H Getchell and Paul F Mahoney Dec 1976 36 p ref (Contract DOT-TSC-372) (PB-263624/9, DOT-TSC-OST-76-44) Avail NTIS HC A03/MF A01 CSCL 17B

The aircraft-to-satellite communications channel was studied as well as instrumentation to accurately simulate the effects of the multipath, Doppler, and additive noise effects of such channels. The simulator provides capability for test and evaluation of communications and navigation equipment under controlled and repeatable conditions without the need for extensive, costly, time-consuming and nonrepeatable field experiments. The basic approach to channel simulation is to split up the signal into several parts, delay each path differently then multiply the delayed signals by a set of complex noise waveforms and sum the results. GRA

N77-24526# Defense Systems Management School Fort Belvoir Va
A VIEW OF THE EVOLUTION OF THE RELIABILITY IMPROVEMENT WARRANTY (RIW)

Allan Edward Schmidt May 1976 47 p refs (AD-A033952) Avail NTIS HC A03/MF A01 CSCL 14/4

This report tracks DOD involvement in and development of a category of warranty which seeks good product reliability and also reliability growth or growth potential (called RIW) that has evolved over a number of years from DOD and industry

experiences. The report provides a historical trail leading to RIW as used in DOD with primary emphasis on the Air Force's recent experience. Some commercial airlines' warranty concepts are discussed, then government and industry views are presented. The report details CODSIA involvement and role in RIW structuring and usage during the current DOD trial test of the concept started in 1973. In 1974 it was further definitized and the term RIW and its concepts were presented for the trial use project. However, no specific trial/test parameters have been established. Currently the individual services may apply RIW as they determine, within overall DOD guidelines. Achievement or consummation of the assessment of RIW's merit, benefits, hazards and policies is the task that DOD is at grips with now. The author suggests alternatives to the current DOD RIW test approach, and recommends that (1) the test be formalized for a period of 1 more year or less, (2) the current RIW programs be evaluated in depth and new programs be added very selectively (or not at all), and (3) DOD CODSIA and ARINC coordinate or compromise on implementation details and contractual provisions based on the findings of the 1-year test (if RIW is approved as a concept for continued use). GRA

N77-24638* Douglas Aircraft Co., Inc., Long Beach, Calif
AIRCRAFT COMMUNITY NOISE IMPACT STUDIES
 Jan 1977 85 p refs
 (Contract NAS1-14488)
 (NASA-CR-145152) Avail NTIS HC A05/MF A01 CSCL 13B

The objectives of the study are to (1) conduct a program to determine the community noise impact of advanced technology engines when installed in a supersonic aircraft, (2) determine the potential reduction of community noise by flight operational techniques for the study aircraft, (3) estimate the community noise impact of the study aircraft powered by suppressed turbojet engines and by advanced duct heating turbofan engines, and (4) compare the impact of the two supersonic designs with that of conventional commercial DC-8 aircraft. Author

N77-24640* National Aeronautics and Space Administration
 Langley Research Center Langley Station, Va
NOISE DATA FOR A TWIN-ENGINE COMMERCIAL JET AIRCRAFT FLYING CONVENTIONAL, STEEP, AND TWO-SEGMENT APPROACHES
 Earl C Hastings Jr., Arnold W Mueller, and John R Hamilton,
 (Integrated Services Inc Hampton, Va.) Washington May 1977
 37 p refs
 (NASA-TN-D-8441 L-11303) Avail NTIS HC A03/MF A01 CSCL 20A

Center-line noise measurements of a twin-engine commercial jet aircraft were made during steep landing approach profiles and during two-segment approach profiles for comparison with similar measurements made during conventional approaches. The steep and two-segment approaches showed significant noise reductions when compared with the -3 deg base line. The measured noise data were also used to develop a method for estimating the noise under the test aircraft at thrust and altitude conditions typical of current landing procedures and of landing procedures under development for the Advanced Air Traffic Control System. Author

N77-25001* Air Force Contract Management Div., Kirtland AFB, N Mex
A METHODOLOGY FOR ESTIMATING JET ENGINE COSTS EARLY IN WEAPON SYSTEM ACQUISITION
 Michael A Yanke 1 Aug 1976 38 p ref
 (AD-A033667) Avail NTIS HC A03/MF A01 CSCL 21/5

The Department of Defense (DOD) is deeply concerned about developing accurate initial estimates for weapon system production costs. An area of particular interest is providing estimates of future production costs for jet engines. Current parametric models used by the Air Force identify engine cost as a function of output variables. Other DOD agencies consider relating input variables as well as output variables to production costs. This study was designed to find a better way to estimate engine production costs. The results of this research include the following findings: (1) current Air Force cost-estimating models are

operationally ineffective, (2) raw materials-related variables are highly correlated with cost and should be considered in developing future cost-estimation models, (3) statistical validation of cost models should incorporate confidence interval testing at a specified alpha level for each prediction, and (4) the use of confidence intervals is the correct statistical approach for developing cost estimates which may be used in decision making. Author (GRA)

N77-25055# Advisory Group for Aerospace Research and Development, Paris (France)
INTEGRITY IN ELECTRONIC FLIGHT CONTROL SYSTEMS
 Apr 1977 367 p
 (AGARD-AG-224, ISBN-92-835-0192-6) Avail NTIS HC A16/MF A01

Flight control systems are described for aircraft safety and reliability. Primary, automatic, and manual controls are discussed.

N77-25056# Systems Technology, Inc., Hawthorne, Calif
A HISTORICAL PERSPECTIVE FOR ADVANCE IN FLIGHT CONTROL SYSTEMS
 Duane McRuer and Dunstan Graham (Princeton Univ., New Jersey)
 In AGARD Integrity in Electron Flight Control Systems Apr 1977 7 p refs
 Avail NTIS HC A16/MF A01

The history of flight control systems is discussed emphasizing early development of theory and practice and automatic control. Several early control approaches are described, showing improvements and changes in the onset of aircraft control systems. M C F

N77-25057# Sperry Flight Systems, Phoenix, Ariz
CHRONOLOGICAL OVERVIEW OF PAST AVIONIC FLIGHT CONTROL SYSTEM RELIABILITY IN MILITARY AND COMMERCIAL OPERATIONS
 S S Osder In AGARD Integrity in Electron Flight Control Systems Apr 1977 17 p refs

Avail NTIS HC A16/MF A01

Flight control system mechanization advances are traced from the perspective of reliability. Despite dramatic advances in device technology and miniaturization, the demand for more functions tended to exceed the progress in electronics. By the latter 1960's, complexity growth related to system monitoring and redundancy management reached limitations of analog technology and set the stage for introduction of digital flight control systems. Author

N77-25058# Civil Aviation Authority, Redhill (England)
SAFETY CRITERIA FOR FAIL-OPERATIONAL AUTOLAND SYSTEMS AND THEIR APPLICATION
 D V Warren In AGARD Integrity in Electron Flight Control Systems Apr 1977 9 p ref

Avail NTIS HC A16/MF A01

The airworthiness requirements for the certification of automatic landing systems in civil aircraft include an explicit statement of the safety level to be achieved. For compliance with these requirements, a safety assessment of the system must be made, and accepted by the airworthiness authority. It must contain a logical analysis which identifies all critical failure conditions of the system and shows that the probability of each is appropriate to the degree of hazard associated with it. It should also examine the factors which influence the performance of the system and show by means of analysis, simulation, and flight testing that the safety level will be acceptable. The analysis will establish the maintenance checks necessary together with their frequency, and any other limitations on the use of the system. Author

N77-25059# Boeing Co., Wichita, Kans
FUTURE TRENDS IN HIGHLY RELIABLE SYSTEMS
 James I Arnold In AGARD Integrity in Electron Flight Control Systems Apr 1977 14 p refs

Avail NTIS HC A16/MF A01

The need for highly reliable flight control systems in both control configured vehicles and conventionally designed aircraft is discussed. Technology trends in the area of control system computation, electronics, sensors and actuation are addressed. Increased use of digital computation and signal multiplexing in future control systems is considered inevitable. Recent technology developments in high density electronic packaging, large scale integration and fiber optics will be applied to achieve highly reliable electronic systems. Component designs will be required to withstand potentially severe environments in the presence of lightning or nuclear phenomena. Redundancy management will continue to be a prime driving force in reliable system designs. The use of in-line monitoring to limit the proliferation of redundant channels should find application in future systems. Maintenance and preflight self-test systems will play an increasingly vital role in ensuring the integrity of redundant flight-critical systems.

Author

N77-25066# Bodenseewerk Geraetetechnik G m b H Ueberlingen (West Germany)

FAILURE SELF-DETECTION IN DIGITAL FLIGHT GUIDANCE SYSTEMS

H Drtil and W Meyer /In AGARD Integrity in Electron Flight Control Systems Apr 1977 7 p

Avail NTIS HC A16/MF A01

Procedures for detecting failures in the hardware of the signal processing are developed. This failure self-detection is carried out by means of suitable test programs and it is supervised by an external supervisor. The design of this supervisor is based on the principle of a watch-dog-timer. Two supervisor systems are developed on the basis of this principle. The improved version allows, in addition the execution of nominal/actual value comparisons in the supervisor, and this increases the failure self-detection probability. The possible applications of the failure self-detection are discussed.

Author

N77-25067# Boeing Co., Houston, Tex

SNEAK CIRCUIT ANALYSIS APPLICATION TO CONTROL SYSTEM DESIGN

Joe L Wilson and Robert C Clardy /In AGARD Integrity in Electron Flight Control Systems Apr 1977 6 p refs

Avail NTIS HC A16/MF A01

The development and application of a circuit analysis technique is presented. The technique is based on an aerospace discovery that topological criteria exist that can be used to recognize unplanned operational modes of a circuit. The analysis technique involves encoding circuitry data from detailed schematics for computer processing. The computer processing produces simplified, topological network trees which represent the system circuitry. The network trees are analyzed by the application of sneak circuit conditions. The results obtained from a variety of complex electrical systems analyses are also presented as positive collaboration for this circuitry analysis technique.

N77-25068# Honeywell, Inc., St. Louis Park, Minn

BUILT-IN TEST TECHNIQUES FOR DIGITAL FLIGHT CONTROL SYSTEMS

W A Plice /In AGARD Integrity in Electron Flight Control Systems Apr 1977 13 p refs

Avail NTIS HC A16/MF A01

The techniques discussed are suitable for use while the flight control system is performing its normal task. Most of these techniques are also applicable on the ground. Since many inputs and outputs of a digital flight control system are analog signals, some analog testing capability is required. The basic concepts of analog testing may often be carried into digital testing. It is shown that stimulated monitoring is possible where the item under test is time multiplexed or where the stimulus can be designed to have a negligible effect on the system performance.

Author

N77-25071# Aeronautical Systems Div., Wright-Patterson AFB, Ohio

TIME-DIVISION MULTIPLEXED DATA BUS INTEGRATION TECHNIQUES

Erwin C Gangel /In AGARD Integrity in Electron Flight Control Systems Apr 1977 9 p refs

Avail NTIS HC A16/MF A01

Today, avionics are demanding an increasing proportion of the resources available for aircraft weapons systems. These avionics are providing increased capability and accuracy to the aircraft weapon system but, also are a prime contributor to increased complexity and decreased reliability of the system. Digital avionics appear to offer the desired increase in capabilities and performance without the normal companions of low reliability, complexity, and high cost because it is amenable to mechanization via solid state devices, it is more orderly and systematic, and provides growth and change without major hardware modification. Digital avionics integration, in order to reap these benefits, requires standard equipment interfaces and a standard approach to data intercommunication. The time division data bus is the technique that permits this new concept of system integration to emerge. The data bus evolutions, its standardization and application are presented. The acquisition management and logistic benefits are discussed.

Author

N77-25072# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

HIGHLY RELIABLE MULTIPROCESSORS

Nicholas D Murray, Albert L Hopkins (Charles Stark Draper Lab., Inc.), and John H Wensley (Stanford Res Inst Menlo Park, Calif) /In AGARD Integrity in Electron Flight Control Systems Apr 1977 17 p refs

Avail NTIS HC A16/MF A01

Highly reliable fault-tolerant computer systems are discussed for use in flight-critical avionics and control systems of future commercial transport aircraft. Such aircraft are envisioned to have integrated systems to be terminally configured, and to be equipped with fly-by-wire flight control systems, all of which require highly reliable, fault-tolerant computers. Two candidate computer architectures are identified as having the potential of satisfying the commercial transport aircraft requirements.

Author

N77-25073# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio Control Systems Development Branch

OBJECTIVES FOR THE DESIGN OF IMPROVED ACTUATION SYSTEMS

B H Earley /In AGARD Integrity in Electron Flight Control Systems Apr 1977 16 p refs

Avail NTIS HC A16/MF A01

Actuation system reliability is particularly critical to the success of modern Flight Control System (FCS) techniques which utilize high authority electrical controls. The reliability combined with typical performance requirements have a substantial effect on the actuator resulting in a high level of sophistication, complexity, attendant high cost and reduced maintainability. A description of actuation systems evolution and several redundant system approaches are included. Significant redundant system criteria are discussed followed by a series of design objectives pertinent to relief of typical actuator problems. A basic design approach is also recommended to assure timely integration of the FCS in the vehicle design process and proper interfacing of the primary technical disciplines. The implementation and benefits of actuation system development programs are discussed and several new actuation concepts are mentioned.

Author

N77-25074# Aeronautical Systems Div., Wright-Patterson AFB, Ohio

F-16 FLIGHT CONTROL SYSTEM DEVELOPMENT

David L Carleton /In AGARD Integrity in Electron Flight Control Systems Apr 1977 9 p refs

Avail NTIS HC A16/MF A01

The purpose of this paper is to outline development procedures required to implement the fly-by-wire flight control system in

the F-16 aircraft. Several developmental efforts were required to implement the flight control system into the aircraft. These efforts include the design and development of specific hardware including the sensors, actuators, and the flight control computer itself. Once the subsystems were developed, the process of integration and definition of the flight control system became a developmental effort. Once the hardware was integrated into the aircraft, the developmental effort then swung towards on-aircraft tests to ensure that the flight control system was compatible with the airframe within the operational flight envelope. Once these ground tests were completed, the development effort then concentrated on the flight test portion of the program where the flight control system was optimized for precision tracking in the air superiority and ground attack role. The F-16 flight control system development was rather unique inasmuch as it was a two-fold effort. A development effort was undertaken to ensure that the prototype aircraft could indeed meet the safety of flight requirements, and then the effort swung towards full scale development of the fly-by-wire flight control system for a production aircraft application. The process is illustrated to expand upon the development process and show how the various steps interact. It also demonstrates the iterative nature of the process.

Author

N77-25076*# National Aeronautics and Space Administration
Hugh L. Dryden Flight Research Center, Edwards, Calif.
DESIGN AND TEST EXPERIENCE WITH A TRIPLY REDUNDANT DIGITAL FLY-BY-WIRE CONTROL SYSTEM

Kenneth J. Szalai, Philip G. Felleman (Charles Stark Draper Lab., Inc.), Joseph Gera (NASA Langley Research Center), and Richard D. Glover (NASA Johnson Space Center). In AGARD Integrity in Electron Flight Control Systems. Apr 1977. 30 p. refs.

Avail NTIS HC A16/MF A01

A triplex digital fly-by-wire flight control system was developed and then installed in a NASA F-8C aircraft to provide fail-operative, full authority control. Hardware and software redundancy management techniques were designed to detect and identify failures in the system. Control functions typical of those projected for future actively controlled vehicles were implemented. The principal design features of the system, the implementation of computer sensor and actuator redundancy management, and the ground test results are described. An automated test program to verify sensor redundancy management software is also described.

Author

N77-25077# Lockheed-California Co., Burbank
L-1011 FLIGHT CONTROL SYSTEM

J. A. Flapper and E. O. Thronsdon. In AGARD Integrity in Electron Flight Control Systems. Apr 1977. 24 p. refs.

Avail NTIS HC A16/MF A01

The L-1011 flight controls—primary and automatic—are described which are of interest because of the state of the art advancements and the improvements which they represent. The flying tail primary control system, its rationale and design features are dealt with in some detail. Integration of primary controls with automatic flight controls is treated and the direct lift control system and roll control briefly described. The automatic controls are described with emphasis on the yaw stability augmentation system and the automatic landing system. The former is in concept an active control system in that design loads are predicated on its availability. The latter, for the final stage of landing in Category 3 conditions, is the forerunner of the fly by wire concept for commercial transports. System rationale or design features which enhance safety and reliability are treated.

Author

N77-25078# Aerospatiale Usines de Toulouse (France)
FLIGHT CONTROLS FOR THE CONCORDE [LES COMMANDES DE VOL DE CONCORDE]

M. Bossard and R. Deque. In AGARD Integrity in Electron Flight Control Systems. Apr 1977. 12 p. In FRENCH.

Avail NTIS HC A16/MF A01

A description of various flight controls for Concorde is presented. System components are listed and performance characteristics are discussed. Electrical flight systems based on the utilization of digital techniques which can be applied to supersonic transport aircraft of second generation were briefly evaluated.

Transl. by B. B.

N77-25079# Royal Aircraft Establishment, Farnborough (England). Dept. of Flight Systems

A HIGH-RELIABILITY, HIGH INTEGRITY FLIGHT CONTROL SYSTEM FOR HELICOPTERS

P. Robinson, J. Mesdows (Smiths Industries Ltd., Gloucestershire, Engl.), and C. M. Copage (Smiths Industries Ltd., Gloucestershire, Engl.). In AGARD Integrity in Electron Flight Control Systems. Apr 1977. 15 p. refs.

Avail NTIS HC A16/MF A01

Some of the operations which helicopters may be required to carry out at night and in poor visibility are briefly described. Because of the high pilot work load likely to arise in these situations, it is argued that the helicopter should be equipped with an autostabilization system having a defect-survival capability. One system to meet this requirement, together with quantitative system reliability and integrity requirements, was developed and manufactured for a Sea King helicopter. This system is triplex, with digital computation, and has the development potential to include autopilot facilities, more sophisticated control techniques, and extended system redundancy. The redundancy philosophy and the approach to assessment of system reliability and integrity are described, together with salient design and engineering details of the system. Also an indication is given of future trends in the technology.

Author

N77-25080*# Systems Research Labs., Inc., Newport News Va. RASA Div

WIND TUNNEL TESTS OF A TWO BLADED MODEL ROTOR TO EVALUATE THE TAMI SYSTEM IN DESCENDING FORWARD FLIGHT

Richard P. White Jr. May 1977. 53 p. refs.

(Contract NAS1-14129)

(NASA-CR-145195, SRL-14-76-2)

Avail NTIS

HC A04/MF A01 CSCL 01A

A research investigation was conducted to assess the potential of the Tip Air Mass Injection system in reducing the noise output during blade vortex interaction in descending low speed flight. In general it was concluded that the noise output due to blade vortex interaction can be reduced by 4 to 6 db with an equivalent power expenditure of approximately 14 percent of installed power.

Author

N77-25081*# Texas A&M Univ. College Station
TRANDES A FORTRAN PROGRAM FOR TRANSONIC AIRFOIL ANALYSIS OR DESIGN Final Report

Leland A. Carlson. Jun 1977. 111 p. refs.

(Grant NSG-1174)

(NASA-CR-2821) Avail NTIS HC A06/MF A01 CSCL 01A

A program called TRANDES is presented that is used for the analysis of steady, irrotational transonic flow over specified two-dimensional airfoils in free air or for the design of airfoils having a prescribed pressure distribution, including the effects of weak viscous interaction. Instructions on program usage, listings of the program, and sample cases are given.

Author

N77-25082*# Rockwell International Corp., Los Angeles, Calif. Aircraft Div

METHOD FOR OBTAINING AERODYNAMIC DATA ON HYPERSONIC CONFIGURATIONS WITH SCRAMJET EXHAUST FLOW SIMULATION Final Report

William R. Hartill. Washington, NASA. Jun 1977. 76 p. refs.

(Contract NAS1-14320)

(NASA-CR-2831 NA-76-752) Avail NTIS HC A05/MF A01

CSCL 01A

A hypersonic wind tunnel test method for obtaining credible aerodynamic data on a complete hypersonic vehicle (generic X-24c) with scramjet exhaust flow simulation is described. The general problems of simulating the scramjet exhaust as well as

accounting for scramjet inlet flow and vehicle forces are analyzed, and candidate test methods are described and compared. The method selected as most useful makes use of a thrust-minus-drag flow-through balance with a completely metric model. Inlet flow is diverted by a fairing. The incremental effect of the fairing is determined in the testing of two reference models. The net thrust of the scramjet module is an input to be determined in large-scale module tests with scramjet combustion. Force accounting is described, and examples of force component levels are predicted. Compatibility of the test method with candidate wind tunnel facilities is described, and a preliminary model mechanical arrangement drawing is presented. The balance design and performance requirements are described in a detailed specification. Calibration procedures, model instrumentation, and a test plan for the model are outlined. Author

N77-25083*# Wichita State Univ., Kans

FORCE AND PRESSURE TESTS OF THE GA(W)-1 AIRFOIL WITH A 20% AILERON AND PRESSURE TESTS WITH A 30% FOWLER FLAP

W H Wentz, Jr., H C Seetharam, and K A Fisco. Washington NASA Jun 1977 96 p refs
(Grant NsG-1165)

(NASA-CR-2833, WSU-AR-76-1) Avail NTIS HC A05/MF A01 CSCL 01A

Wind tunnel force and pressure tests were conducted for the GA(W)-1 airfoil equipped with a 20% aileron and pressure tests were conducted with a 30% Fowler flap. All tests were conducted at a Reynolds number of 2.2 and a Mach number of 0.13. The aileron provides control effectiveness similar to ailerons applied to more conventional airfoils. Effects of aileron gaps from 0% to 2% chord were evaluated as well as hinge moment characteristics. The aft camber of the GA(W)-1 section results in a substantial up-aileron moment, but the hinge moments associated with aileron deflection are similar to other configurations. Fowler flap pressure distributions indicate that unseparated flow is achieved for flap settings up to 40 deg. over a limited angle of attack range. Theoretical pressure distributions compare favorably with experiments for low flap deflections, but show substantial errors at large deflections. Author

N77-25084*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

EXPERIMENTAL PERFORMANCE OF A 16 10-CENTIMETER-TIP-DIAMETER SWEEPBACK CENTRIFUGAL COMPRESSOR DESIGNED FOR A 6.1 PRESSURE RATIO

Hugh A Klassen, Jerry R Wood, and Lawrence F Schumman. Jun 1977 31 p refs

(NASA-TM-X-3552, E-9074) Avail NTIS HC A03/MF A01 CSCL 21E

A backswept impeller with design mass flow rate of 1.033 kg/sec was tested with both a vaned diffuser and a vanedless diffuser to establish stage and impeller characteristics. Design stage pressure ratio of 5.91 was attained at a flow slightly lower than the design value. Flow range at design speed was 6 percent of choking flow. Impeller axial tip clearance at design speed was varied to determine effect on stage and impeller performance. Author

N77-25085*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

EFFECT OF WINGLETS ON A FIRST-GENERATION JET TRANSPORT WING 1. LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A SEMISPAN MODEL AT SUBSONIC SPEEDS

Peter F Jacobs, Stuart G Flechner, and Lawrence C Montoya. Jun 1977 50 p refs

(NASA-TN-D-8473, L-11354) Avail NTIS HC A03/MF A01 CSCL 01A

Longitudinal aerodynamic characteristics and cross-flow velocity vectors behind the wing tip of a first-generation jet transport semispan model are presented at subsonic speeds. Data are given for the basic wing and configurations with an upper winglet only, upper and low winglets, and a simple wing-tip extension. To simulate second-segment-climb lift conditions,

leading- and/or trailing-edge flaps were added to some configurations. Author

N77-25086*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

STATIC AND WIND-ON TESTS OF AN UPPER-SURFACE-BLOWN JET-FLAP NOZZLE ARRANGEMENT FOR USE ON THE QUIET CLEAN SHORT-HAUL EXPERIMENTAL ENGINE (QCSEE)

Arthur E Phelps, III. Jun 1977 44 p refs

(Da Proj 1L1-61102-AH-45)

(NASA-TN-D-8476, L-11421) Avail NTIS HC A03/MF A01 CSCL 01A

The internal aerodynamic performance, the static turning characteristics and the forward-speed characteristics of two 1/12-scale upper surface-blown jet-flap exhaust-nozzle arrangements designed for use on the Quiet Clean Short-Haul Experimental Engine (QCSEE) were investigated. The nozzles were equipped with interchangeable area-control side doors in the aft sidewalls of the nozzle so that the effective nozzle area could be varied over a wide range. A simulated wing was used to evaluate installation losses for the nozzles. A smoothly curved flap was attached to the trailing edge of the simulated wing to allow an evaluation of the static turning characteristics of the nozzle arrangement. Forward-speed effects on the jet turning characteristics of the QCSEE nozzles were evaluated by mounting a single engine on a semispan wing designed to be representative of a four-engine STOL transport configuration. Author

N77-25088*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

LASER VELOCIMETER MEASUREMENTS OF TWO-BLADED HELICOPTER ROTOR FLOW FIELDS

James C Biggers, Albert Lee (AAMRD, Moffett Field, Calif), Kenneth L Orloff, and Opal J Lemmer (Beam Eng Inc.) May 1977 158 p refs

(NASA-TM-X-73238, A-7071) Avail NTIS HC A08/MF A01 CSCL 01A

Data from a wind tunnel investigation of the flow fields around helicopter rotors were presented. A two component laser velocimeter was used to measure the velocity fields of two 2.1 m diameter rotors. A minicomputer-based online data system is described which monitored, reduced, and plotted the results. Tip vortices constitute the primary disturbances in the flow field, but present theories do not predict vortex positions and velocity distributions with sufficient accuracy. Author

N77-25090*# Wichita State Univ., Kans

A LOW SPEED TWO-DIMENSIONAL STUDY OF FLOW SEPARATION ON THE GA(W)-1 AIRFOIL WITH 30-PERCENT CHORD FOWLER FLAP

H C Seetharam and W H Wentz, Jr. Washington NASA May 1977 73 p refs

(Grant NGR-17-003-021)

(NASA-CR-2844) Avail NTIS HC A04/MF A01 CSCL 01A

Measurements of flow fields with low speed turbulent boundary layers were made for the GA(W)-1 airfoil with a 0.30 c Fowler flap deflected 40 deg at angles of attack of 2.7 deg, 7.7 deg and 12.8 deg at a Reynolds number of 2.2 million, and a Mach number of 0.13. Details of velocity and pressure fields associated with the airfoil flap combination are presented for cases of narrow, optimum and wide slot gaps. Extensive flow field turbulence surveys were also conducted employing hot-film anemometry. For the optimum gap setting, the boundaries of the regions of flow reversal within the wake were determined by this technique for two angles of attack. Local skin friction distributions for the basic airfoil and the airfoil with flap (optimum gap) were obtained using the razor blade technique. Author

N77-25092*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

CORRELATION OF PART-SPAN DAMPER LOSSES THROUGH TRANSONIC ROTORS OPERATING NEAR DESIGN POINT

William B Roberts (Notre Dame Univ., Ind.) Washington Jun 1977 23 p refs
(NASA-TM-X-3542, E-9068) Avail NTIS HC A02/MF A01
CSC L 01A

The design-point losses caused by part-span dampers (PSD) were correlated for 21 transonic axial flow fan rotors that had tip speeds varying from 350 to 488 meters per second and design pressure ratios of 1.5 to 2.0. For these rotors a correlation using mean inlet Mach number at the damper location, along with relevant geometric and aerodynamic loading parameters, predicts the variation of total pressure loss coefficient in the region of the damper to a good approximation. Author

N77-25094# National Aerospace Lab., Amsterdam (Netherlands) Scientific Services

A PROGRAM FOR THE COMPUTATION OF A COMPRESSIBLE TURBULENT BOUNDARY LAYER UNDER INFINITE SWEEP WING CONDITIONS

J P F Lindhout and E DeBoer 30 Jun 1975 44 p refs
(Contract RNLAF-RB-KLu-1974)
(NLR-TR-75090-U) Avail NTIS HC A03/MF A01

A method is presented to compute the 3D compressible turbulent boundary layer on an adiabatic wall under infinite swept wing conditions. The mathematical model of turbulence is based on a generalization of Bradshaw's 2D shear stress equation. The method consists of the solution of five nonlinear hyperbolic differential equations valid along five distinct characteristics. A brief discussion is devoted to the choice of a suitable difference scheme. The FORTRAN program is described. Some results of calculations in practical cases are shown and suggest that the program can be applied successfully, however, a more extensive analysis of calculations and measurements is necessary to estimate the abilities of the method. The listing of the program and an example of input/output are obtainable on request. Author (ESA)

N77-25096# National Aerospace Lab., Amsterdam (Netherlands) Fluid Dynamics Div

APPLICATION OF PANEL METHODS FOR UNSTEADY SUBSONIC FLOW

R Roos May 1976 42 p refs. Presented at the Euromech Colloq 75 on Calculation of Flow Fields by Means of Panel Methods, Brunswick, 10-13 May 1976. Sponsored by Air Mater Directorate of the Roy Neth. Air Force
(NLR-MP-76010-U) Avail NTIS HC A03/MF A01

A survey is given of results obtained with two panel methods for the calculation of the aerodynamic loading on oscillating airplane configurations in subsonic flow. The methods involved are the doublet-lattice method for thin lifting surfaces and the NLR-panel method for wing-body combinations. After a short outline of each their merits are discussed in view of practical applications. Some of the latest results, including pressure distributions, load distributions and dynamic stability derivatives, are given. Finally a simple method is outlined by which unsteady panel methods for thin lifting surfaces may be pushed into the high subsonic speed range through the use of local Mach number corrections. Author (ESA)

N77-25097# National Aerospace Lab., Amsterdam (Netherlands) Scientific Services

THE CALCULATION OF AERODYNAMIC CHARACTERISTICS OF WING-BODY COMBINATIONS AT SUBSONIC FLIGHT SPEEDS

W Loeve Jun 1976 11 p refs. Presented at the 6th Intern Conf on Numerical Methods in Fluid Dyn., Enschede, Neth. 28 Jun - 3 Jul 1976
(NLR-MP-76017-U) Avail NTIS HC A02/MF A01

Surface panel methods and finite difference methods are reviewed with respect to the use in the design of airplanes. It is concluded that there is a need for inverse surface panel type methods to diminish the trial and error character of the design process. Finite difference methods based on transonic small perturbation theory must be based on an equation that is the proper small perturbation of the mass conservation law. The only sensible next step in the development seems to be the solution of the full potential equation applying correct boundary conditions. Author (ESA)

N77-25101# Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept

EFFECT OF PRODUCTION MODIFICATIONS TO REAR OF WESTLAND LYNX ROTOR BLADE ON SECTIONAL AERODYNAMIC CHARACTERISTICS

P G Wilby London Aeron Res Council 1977 21 p refs
Supersedes RAE-TR-73043, ARC-34835
(ARC-CP-1362, RAE-TR-73043, ARC-34835) Avail NTIS
HC A02/MF A01, HMSO £1 50, PHI \$5 80

The RAE (NPL) 9615 airfoil was accepted, on the basis of wind tunnel tests, as the basic blade section for the Westland WG 13 Lynx helicopter rotor, however production methods necessitated a modification to the rear profile of the blades which was considered sufficient to produce changes in the aerodynamic characteristics of the airfoil. Thus, the modified profile was tested in the wind tunnel and the experimental data compared with those for the original profile. The main effects of the modification were found to be a small increase in maximum lift, a small decrease in supercritical drag, and a reduced range of pitching moment coefficient. These changes arise from the generation of a small increment of lift, over the rear of the airfoil, which increases progressively from zero as incidence increases from zero. Author (ESA)

N77-25102# Southampton Univ. (England) Dept of Aeronautics and Astronautics

THE BEHAVIOR OF A CONICAL VORTEX SHEET ON A SLENDER WING NEAR THE LEADING EDGE

G J Clapworthy and K W Mangler London Aeron Res Council Oct 1974 36 p refs. Supersedes RAE-TR-74150, ARC-35901

(ARC-R/M-3790, RAE-TR-74150, ARC-35901) Avail NTIS
HC A03/MF A01, HMSO £4, PHI \$15 30

The inviscid flow field past a slender delta wing at incidence with leading-edge separation can be considered as conical. The shape of the resulting vortex sheet has been calculated previously. Here the behavior of the sheet near the leading edge of the wing is investigated and an expansion of the solution in this neighborhood is found by the application of certain theorems of the theory of complex functions. It is shown that in a cross-flow plane (normal to the undisturbed flow) the slope of the sheet can be expressed in powers of the square root of the arc length measured along the sheet. A related series expansion is found for the strength of the vortex sheet. The sheet is always tangential to the pressure side of the wing. On the suction side of a wing with thickness the flow is parallel to the leading edge so that the strength of the vortex sheet at the leading edge is directly related to the overall circulation around the sheet. Author (ESA)

N77-25103# Aeronautical Research Inst of Sweden Stockholm Aerodynamics Dept

WIND TUNNEL HIGH LIFT OPTIMIZATION OF A MULTIPLE ELEMENT AIRFOIL. Final Report

B Ljungstroem 1976 118 p refs
(Contracts F-INK-82223-68-001-07-001,
F-INK-82223-69-002-07-001, F-INK-82223-71-302-07-001,
F-INK-82223-70-807-07-001, F-INK-82223-72-004-07-001,
F-INK-82223-73-009-07-001)
(FFA-TN-AU-778) Avail NTIS HC A06/MF A01

Wind tunnel tests were carried out with a two-dimensional high lift wing based on a NACA 652-215 wing section. Three different configurations were tested: basic wing section (with flaps retracted), take-off configuration (with single slotted flap and leading edge slat) and landing configuration (with a double slotted flap and a leading edge slat). The objectives were to optimize the geometry of the configurations for the take-off and the landing case. A large number of parameter variations were made. The best maximum lift result is 5.0 for a 55 deg double slotted flap and a 20 deg leading edge slat. The importance of aerodynamic interaction between the leading edge and the trailing edge was shown clearly. Optimization of the slat position has considerable effect on the flap flow for high angles of attack. The optimum slat gap was shown to increase rapidly with decreasing slat angle. The optimum first flap gap increases slowly with increasing flap angle and is approximately twice the size of the optimum second flap gap. A similarity between CL maximum

lift trends for the present 2-D tests with 3-D tests (18 deg sweep angle AR = 7) is shown
Author (ESA)

N77-25104# Aeronautical Research Inst of Sweden, Stockholm
Aerodynamics Dept
WING-BODY INTERFERENCE AT MODERATE SUPER-SONIC SPEEDS. A COMPARISON BETWEEN PANEL METHOD AND EXPERIMENT Final Report

Erk Larson and Nada Agrell 1976 122 p refs Original contains color illustrations

(Contract F-INK-13-13316)

(FFA-TN-AU-940) Avail NTIS HC A06/MF A01

A comprehensive inspection of the possibility of obtaining, from the panel method, reliable load distributions and partial load ratios at the side of total normal-force and pitching-moment data in the low angle of attack region for wing-body combinations at moderate supersonic speeds was carried out. Several wing families of different planform in combination with an ogive-cylinder body were investigated. The planforms on the wings range from unswept leading-edge wings to delta wings. The trailing-edge is either swept forward 45 deg or unswept. By means of clipping the wing tips, the planform and the aspect ratio of the wing within a wing family was successively decreased. The computed result was in several cases compared with experiment and the correlation is convincing as long as the linear flow characteristics dominate which seems to be the case as long as the wing-tips are unclipped. As soon as a side edge is present, the panel method in its present formulation can not give satisfactory results for the load distribution on the body and the corresponding pitching-moment in the first place. For rectangular wing-body combinations of the classical type, it can be concluded that the panel method has added practically nothing as to the possibility of obtaining a reliable load distribution on the body and a corresponding pitching-moment. This is not surprising because the problem of obtaining a realistic downwash field behind the wing is not solvable within linear aerodynamics. The panel method is in this respect a computerized solution of the rectangular wing-body problem, only. From the rich data bank, a number of ratios between partial loads on wing-body combinations were inspected and, in several cases, compared with slender body-theory
Author (ESA)

N77-25105# European Space Agency, Paris (France)
CALCULATION OF FLOW FIELDS WITH SEPARATION BUBBLES AT HIGH REYNOLDS NUMBER

Dieter Geropp et al May 1977 64 p refs Transl into ENGLISH of 'Berechnung von Stromungsfeldern mit Abloeseblasen bei grossen Reynoldszahlen', DFVLR, Karlsruhe, West Ger Report DLR-FB-76-52, 27 Sep 1976 Original report in GERMAN previously announced as N77-21056 Original German report available from DFVLR, Cologne DM 25,30
(ESA-TT-378, DLR-FB-76-52) Avail NTIS HC A04/MF A01

The two-dimensional, steady, incompressible flow around a body is divided into five zones and is idealized: external flow - potential flow, attached flow - boundary layer, dead-air flow - fictive body causing a typical pressure distribution, flow between the bubble and the dead-air - boundary layer, separation bubble - fictive thickening on the body causing a typical pressure distribution. The influence of the dead-air, the bubble, and the boundary layer on the external flow are simulated by a fictive body, its shape being calculated in analogy to the method of Grashof (1973). For the air foil section Goe801 pressure distributions were calculated and compared with experimental data
Author (ESA)

N77-25107# Office National d'Etudes et de Recherches Aeronautiques, Paris (France)
BEHAVIOR OF A SUBSONIC FLOW PAST A THIN WING IN THE VICINITY OF THE LEADING EDGE

Jean-Sylvestre Darrozes Feb 1977 40 p refs In FRENCH, ENGLISH summary Report will also be announced as translation (ESA-TT-401)

(ONERA-NT-1976-16 FR-ISSN-0078-3781) Avail NTIS HC A03/MF A01

The technique of matched asymptotic expansions leads to a uniformly valid description of a subsonic flow past a thin wing

with round edges. The outer solution is the classical one given by the linearized theory. The inner problem requires a local formulation which corresponds to a local subsonic flow past a parabola in a plane normal to the leading edge. The inner solution is given explicitly in the case of weakly subsonic flows
Author (ESA)

N77-25109# Ballistic Research Labs Aberdeen Proving Ground, Md

EXPERIMENTAL MEASUREMENTS OF THE TURBULENT BOUNDARY LAYER ON A YAWED, SPINNING SLENDER BODY Final Report

Walter B Sturek and James E Danberg Jan 1977 29 p refs

(DA Proj 1L1-61102-AH-43)

(AD-A035269, BRL-1954) Avail NTIS HC A03/MF A01 CSCL 20/4

Experimental measurements of the tripped turbulent boundary layer profile characteristics on a yawed, spinning tangent-ogive-cylinder model are described. The profile measurements were made using a flattened total head probe at 30 deg increments completely about the azimuthal plane for three longitudinal stameter by a factor of two from the wind to the lee-side. A small but consistent effect of spin is also apparent
Author (GRA)

N77-25110# Naval Ship Research and Development Center, Bethesda, Md Aviation and Surface Effects Dept

EXPERIMENTAL EVALUATION OF THE EFFECT OF ROTATION ON THE AERODYNAMIC CHARACTERISTICS OF TWO ROTOR HUB FAIRING SHAPES

Peter S Montana Sep 1976 71 p refs

(WF41421201)

(AD-A033555, DTNSRDC/ASED-364)

Avail NTIS

HC A04/MF A01 CSCL 20/4

An experiment was performed to demonstrate that the drag of rotor hub fairings for high speed helicopters is not a function of advance ratio. Two hub fairing shapes were evaluated both with and without simulated blade shanks over a range of hub advance ratios from 0.5 to infinity. It was determined that the drag coefficient, and most other coefficients, is constant for hub advance ratios greater than about 3.0
Author (GRA)

N77-25111# Naval Ship Research and Development Center, Bethesda, Md Aviation and Surface Effects Dept

EXPERIMENTAL EVALUATION OF ANALYTICALLY SHAPED HELICOPTER ROTOR HUB-PYLON CONFIGURATIONS USING THE HUB PYLON EVALUATION RIG

Peter S Montana Jul 1976 104 p refs

(WF41421201)

(AD-A033554, DTNSRDC/ASED-355)

Avail NTIS

HC A06/MF A01 CSCL 20/4

The hub-pylon evaluation rig, a new facility for wind tunnel experiments on large scale helicopter rotor hub-pylon configurations, was used to determine the variation of hub-pylon drag with shaft angle and height, and pylon angle parameters. In addition, a series of low drag area rule fairings and shaft fairings were evaluated. The results indicate that the proper selection of shaft angle with respect to the pylon and pylon angle of attack can yield a twenty percent reduction in drag for a given shaft angle of attack. An additional reduction in drag of at least twenty percent is achievable with a properly designed area rule fairing
Author (GRA)

N77-25116# ARO, Inc., Arnold Air Force Station, Tenn
AN INVESTIGATION OF THE HALF-MODEL REFLECTION-PLANE TECHNIQUE FOR DYNAMIC STABILITY TESTING AT TRANSONIC MACH NUMBERS Final Report, 16 Jan 1973 - 31 Mar. 1976

T O Shadow AEDC Jan 1977 94 p refs

(AD-A035567, ARO-PWT-TR-76-127 AEDC-TR-76-165) Avail NTIS HC A05/MF A01 CSCL 20/4

An experimental investigation was made to determine the feasibility of the half-model reflection-plane technique for measuring dynamic stability derivatives in the transonic speed

range Three model configurations simulating an aircraft a missile, and a bluff body were investigated both full and half span at Mach numbers from 0.6 to 1.2 and angles of attack from -2 to 90 deg The half-model reflection-plane technique fully duplicated the full-span results only at subsonic subcritical speeds and angles of attack up to 20 deg In tests at higher Mach numbers in the transonic range and higher angles of attack up to 90 deg it was not demonstrated that the half-model technique can provide better than qualitative order of magnitude results GRA

N77-25126# National Aviation Facilities Experimental Center Atlantic City N J
FLIGHT TEST AND EVALUATION OF MDEC (MCDONNELL DOUGLAS ELECTRONICS CORPORATION) COLLISION AVOIDANCE SYSTEM Final Report, Jan - Oct 1975
 Theodore J Turnock Henry Scozzafava John J Wojciech, and Kent T Culbertson Feb 1977 274 p refs
 (AD-A037435/5 FAA-NA-76-23 FAA-RD-75-231) Avail NTIS HC A12/MF A01 CSCL 01/2

The test and evaluation of commercial and general aviation versions of airborne collision avoidance system (ACAS) equipments which are candidates for selection in a National Standard Collision Avoidance System are covered The CAU (collision avoidance unit) and Mini-CAS were evaluated for their communications range reliability, synchronization and their ability to provide timely and correct advisories and maneuver commands In addition range and range rate accuracy and display reliability were analyzed It is concluded that the CAU and Mini-CAS equipments perform the collision avoidance function as described in ANTC 117 The operation of the ground and airborne equipment along with brief descriptions of the aircraft installation, test instrumentation, flight test outline, and the various problems encountered during the evaluation are summarized Author

N77-25127# National Transportation Safety Board Washington, D C Bureau of Technology
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA, US GENERAL AVIATION, CALENDAR YEAR 1975 Aircraft Accident Data 1975 (summary)
 25 Jan 1977 200 p
 (PB-264394/8 NTSB-ARG-77-1) Avail NTIS HC A09/MF A01 CSCL 01B

Statistical information compiled from reports of 4 237 general aviation accidents that occurred during the calendar year 1975 is presented Included in the total number of accidents are 51 collisions between aircraft By coding each aircraft involved in the collisions an additional 51 records were produced, which brought total accident records to 4,288 This figure reflects that actual number of pilots and aircraft involved in the accidents GRA

N77-25129# CACI Inc Arlington Va
STATISTICAL ANALYSES APPLIED TO THE US NAVY AIRCREW AUTOMATED ESCAPE SYSTEMS
 Henry L Crowson 30 Nov 1976 96 p
 (Contract N00019-76-C-0034)
 (AD-A035067 NAVWESA-R-7605) Avail NTIS HC A05/MF A01 CSCL 06/7

Statistical analyses methodologies, such as analysis of variance non-parametric tests and hypothesis tests were applied to uncover trends and dependencies of ejection-related injuries Ejection-related fatality patterns for the A-6 aircraft were developed deterministically The A-4 A-5 A-6, A-7 F-4 F-8 and F-9 ejection-related injuries were investigated and parent probability density functions derived The A-4 A-6, A-7 F-4 and F-8 contain an underlying injury trend Fatalities occur randomly upon ejection from the A-4 A-7 F-4 and F-8 aircraft Fatalities do not occur randomly from the A-6 aircraft Differences were revealed among various ejection fatality scenarios hardware hazards, aircrew judgment environmental conditions aircraft associated with ejections and ejection seats used in ejection Author (GRA)

N77-25130# CACI, Inc., Arlington Va
STATISTICAL ANALYSIS METHODOLOGY FOR THE US NAVY AIRCREW AUTOMATED ESCAPE SYSTEMS Final Report

Henry L Crowson 15 May 1976 129 p refs
 (Contract N00019-76-C-0034)
 (AD-A035068, NAVWESA-R-7605) Avail NTIS HC A07/MF A01 CSCL 06/7

A statistical analysis methodology is proposed for the study of Aircrew Automated Escape Systems A detailed explanation is given for the following (1) data analysis, (2) applicable discrete probability density functions to include the binomial Poisson, and multinomial (3) Bayesian statistical theory and applications (4) higher order contingency table data analysis, and (5) non-parametric (distribution free) statistical tests to include the run test and trend test and Fishers Exact Test Continuous probability density functions discussed include the normal, gamma and beta density functions A brief exposition of small sample statistical analysis to include sampling probability density functions, is also given The sampling probability density functions considered are the Chi-Square T and F Author (GRA)

N77-25132# Aeronautical Systems Div Wright-Patterson AFB Ohio
AERONAUTICAL SYSTEMS TECHNOLOGY NEEDS ES-CAPE, RESCUE, AND SURVIVAL Annual Report, Jan - Dec 1977
 Donald C Kittinger Jan 1977 22 p Supersedes ASD-TR-77-2
 (AD-A035251 ASD-TR-77-2) Avail NTIS HC A02/MF A01 CSCL 06/7

This report is a part of a compilation of formalized Technology Needs (TN) covering Equipment Subsystems as identified by the Aeronautical Systems Division They are based on development/operational experience systems studies and new concepts - all related to future system applications Their presentation is to serve a threefold purpose i.e., (1) guidance for technology program, (2) proven developmental potential, and (3) engineering data/requirements essential for technology use in systems The identified needs delineate progress desired in performance control, design flexibility, safety, and cost Author (GRA)

N77-25134# Noah (J Watson) Associates Inc Falls Church, Va
COST BENEFIT ANALYSIS AND THE NATIONAL AVIATION SYSTEM A GUIDE Final Report
 J Watson Noah, R A Groemping, J E Berterman, and O L Greynolds Feb 1977 230 p refs
 (Contract DOT-FA76WA-3769)
 (AD-A037434/8, FR-1191-FAA FAA-AVP-77-15) Avail NTIS HC A11/MF A01 CSCL 01/2

A method is described for determining cost benefits of the national aviation system Selected values for potential use in Federal Aviation Administration studies are discussed along with the principles, concepts, and techniques appropriate to estimating benefits and life cycle costs In addition, parameters useful for valuing changes in capacity, delay, and aviation safety are presented Author

N77-25135# Institute for Telecommunication Sciences, Boulder Colo
THE MEASUREMENT OF MICROWAVE MULTIPATH IN AN AIRPORT ENVIRONMENT Final Report
 R W Hubbard, L E Pratt and W J Hartman Jan 1977 74 p refs
 (Contract DOT-FA74WAI-471)
 (AD-A037791/1, FAA-RD-76-163) Avail NTIS HC A04/MF A01 CSCL 17/7

Multipath in an operating airport and its impact on the performance of a microwave landing system (MLS) is an important aspect of the development of these systems Test programs on the candidate MLS systems developed in the U S were conducted in areas that do not emulate large commercial airports In order to better evaluate multipath in a realistic environment measurements of reflected signals at the MLS operating frequency were performed and the results used to develop or modify a computer simulation program Both a cw system and a pseudorandom noise channel probe were used in the measurement program The results of multipath measurements made on (1) airport terminal buildings, (2) large maintenance hangars and (3) aircraft

on the surface of the airport are presented. Significant reflection levels are prevalent from these sources and can produce a multipath reception problem at the receiver of an aircraft approaching the runway. Author

N77-25136# National Aerospace Lab, Amsterdam (Netherlands) Flight Dynamics Div

EXPLORATORY INVESTIGATION OF DECELERATING APPROACHES OF A TWIN-ENGINE JET TRANSPORT VOLUME 1 FIXED-BASE SIMULATION

C F G M Hofman 26 Mar 1976 86 p refs

(Contracts NIVR-1747 RB-RDL-74-1)

(NLR-TR-75171-U) Avail NTIS HC A05/MF A01

An exploratory investigation on a fixed-base flight simulator was conducted in order to obtain pilots' opinions on decelerating approaches and to determine what would be required to enable pilots to fly these approaches. A twin-engine jet transport aircraft of the Douglas DC-9-10 type was used. The symmetric equations of motion were programmed on an analog computer. Five approach procedures were investigated and four airline pilots contributed to the execution of the flight tests. All approaches were simulated in moderate to severe atmospheric turbulence. Pilots were asked to give their opinion on the acceptability of the various procedures. Statistical tests for measured performance variables and ratings to compare the various procedures were performed. It was concluded that a simulation investigation with a moving base flight simulator and a more complete simulated aircraft is recommended in order to present the pilots with more realistic circumstances. ESA

N77-25137# Plessey Co Ltd, Addlestone (England) Engineering Dept

STUDY OF THE INTEGRATION AND EVALUATION OF AN AERONAUTICAL SATELLITE SYSTEM IN OCEANIC AIR TRAFFIC CONTROL CENTRE Final Report

J Neal, E J Bishop, A Flint, W Sewell, and I Griffith 23 Nov 1971 118 p refs 2 Vol

(Contract ESTEC-1346/71-GC)

(Rept-84/71/37-Vol-1) Avail NTIS HC A06/MF A01

An analysis is presented of a system using aeronautical satellites as a means of providing an air traffic control facility in the North Atlantic (Aerosat system). The main concern is achievement of a reduction of separation standards. Criteria for systems evaluation, and for systems performance judgement, were developed. The information flow between pictorial and tabular displays and computer elements is discussed. The effects of several parameters on systems models are described. Functions of a central computer are studied. Effects of signal loss are considered. ESA

N77-25138# Plessey Co Ltd, Addlestone (England) Engineering Dept

STUDY OF THE INTEGRATION AND EVALUATION OF AN AERONAUTICAL SATELLITE SYSTEM IN OCEANIC AIR TRAFFIC CONTROL CENTRE Final Report

J Neal, E J Bishop, A Flint, W Sewell, and I Griffith 23 Nov 1971 102 p 2 Vol

(Contract ESTEC-1346/71-GC)

(Rept-84/71/42-Vol-2) Avail NTIS HC A06/MF A01

An analysis is presented of a system using aeronautical satellites as a means of providing an air traffic control (ATC) facility in the North Atlantic (Aerosat system). The alarm thresholds required to enable an ATC function to be carried out are analyzed. A method of allocating flights to lanes and time slots, as well as showing how flight paths can be merged and crossed, is defined. A likely flow of information along the surveillance and communication channels and across subsystem interfaces is analyzed. System operation under certain failure conditions is outlined. ESA

N77-25139# Societe d'Etudes des Systemes d'Automation, Paris (France)

STUDY OF THE INTEGRATION AND EVALUATION OF AIR TRAFFIC CONTROL SYSTEMS IN AN AERONAUTICAL SATELLITE SYSTEM, VOLUME 1 Final Report [ETUDE THEORIQUE DE L'INTEGRATION ET DE L'EVALUATION

DES SYSTEMES DE CONTROLE DE LA CIRCULATION AERIEENNE DANS LE CADRE D'UN SYSTEME DE SATELLITES AERONAUTIQUES, TOME 1]

18 Nov 1971 155 p In FRENCH 2 Vol

(Contract ESTEC-1377/71-CG)

(SESA-Ex-5030/14639/71-Vol-1)

Avail

NTIS

HC A08/MF A01

An analysis of a system using aeronautical satellites as a means of providing an air traffic control facility in the North Atlantic (Aerosat system) is presented. The present air traffic situation is described and its future growth discussed. A system is proposed consisting of a ground station network and two aeronautical satellites. The flight path structure and oceanic control intervention modes are discussed. Tasks of the oceanic control center related messages and communication channels are detailed. ESA

N77-25140# Societe d'Etudes des Systemes d'Automation, Paris (France)

STUDY OF THE INTEGRATION AND EVALUATION OF AIR TRAFFIC CONTROL SYSTEMS IN AN AERONAUTICAL SATELLITE SYSTEM, VOLUME 2 Final Report [ETUDE THEORIQUE DE L'INTEGRATION ET DE L'EVALUATION DES SYSTEMES DE CONTROLE DE LA CIRCULATION AERIEENNE DANS LE CADRE D'UN SYSTEME DE SATELLITES AERONAUTIQUES, TOME 2]

18 Nov 1971 123 p refs In FRENCH 2 Vol

(Contract ESTEC-1377/71-CG)

(SESA-Ex-5030/14639/71-Vol-2)

Avail

NTIS

HC A06/MF A01

An analysis of a system using aeronautical satellites as a means of providing an air traffic control facility in the North Atlantic (Aerosat system) is presented. Hardware and Software configurations for the ground space, and mobile system segment are considered. The effect of failures is analyzed. Problems occurring in case of systems extension are surveyed. A theoretical study on the reduction of separation standards is reported. ESA

N77-25141# National Aerospace Lab, Amsterdam (Netherlands) Scientific Services and Special Projects Div

A SLOTTED WAVEGUIDE ANTENNA AS A MARKER BEACON FOR AIRCRAFT

O B M Pietersen and F Klinker 1 Jul 1975 15 p refs Presented at the IEEE/AP-S Intern Symp, Urbana/Champaign III, 2-5 Jun 1975 Revised

(NLR-MP-75027-U-Rev) Avail NTIS HC A02/MF A01

A position marker system used in aircraft certification flights is described. The system consists of a ground-based part, viz a microwave transmitter and a fan-beam antenna, and an airborne part composed of receiving antenna, a crystal-video receiver, and a processor which interfaces the system to the usual recording equipment. Most attention is given to the design of the fan-beam antenna since the performance of the system depends heavily on it. Some measurement results of the antenna are given. For heights less than 1,000 m, the aircraft position can be determined (in one dimension) with the accuracy of a few meters. It is concluded that the signal in space generated by a slotted waveguide antenna which is fed in the center and used in the difference mode, is suitable as a position marker signal for aircraft. Author (ESA)

N77-25147*# Boeing Commercial Airplane Co, Seattle, Wash **STUDY OF STRUCTURAL DESIGN CONCEPTS FOR AN ARROW WING SUPERSONIC TRANSPORT CONFIGURATION, VOLUME 1. TASKS 1 AND 2 Final Report**

Aug 1976 212 p refs

(Contract NAS1-12287)

(NASA-CR-132576-Vol-1, D6-42438-Vol-1) Avail NTIS

HC A10/MF A01 CSCL 01C

A structural design study was made, based on a 1975 level of technology, to assess the relative merits of structural concepts and materials for an advanced supersonic transport cruising at Mach 2.7. Preliminary studies were made to insure compliance of the configuration with general design criteria, to integrate the propulsion system with the airframe, to select structural concepts and materials, and to define an efficient structural arrangement.

An advanced computerized structural design system was used, in conjunction with a relatively large, complex finite element model, for detailed analysis and sizing of structural members to satisfy strength and flutter criteria. A baseline aircraft design was developed for assessment of current technology and for use in future studies of aerostructural trades, and application of advanced technology. Criteria, analysis methods, and results are presented. Author

N77-25148* Boeing Commercial Airplane Co., Seattle, Wash
STUDY OF STRUCTURAL DESIGN CONCEPTS FOR AN ARROW WING SUPERSONIC TRANSPORT CONFIGURATION, VOLUME 2. TASKS 1 AND 2 Final Report

Aug 1976 667 p refs

(Contract NAS1-12287)

(NASA-CR-132576-Vol-2, D6-42438-Vol-2) Avail NTIS HC A99/MF A01 CSCL 01C

For abstract, see N77-25147

N77-25149* Virginia Univ., Charlottesville
DEVELOPMENT OF A DIGITAL AUTOMATIC CONTROL LAW FOR STEEP GLIDESLOPE CAPTURE AND FLARE Final Report

Nesim Halyo Washington NASA Jun 1977 69 p refs

(Grant NAS1-12754)

(NASA-CR-2834) Avail NTIS HC A04/MF A01 CSCL 01C

A longitudinal digital guidance and control law for steep glideslopes using MLS (Microwave Landing System) data is developed for CTOL aircraft using modern estimation and control techniques. The control law covers the final approach phases of glideslope capture, glideslope tracking, and flare to touchdown for automatic landings under adverse weather conditions. The control law uses a constant gain Kalman filter to process MLS and body-mounted accelerometer data to form estimates of flight path errors and wind velocities including wind shear. The flight path error estimates and wind estimates are used for feedback in generating control surface commands. Results of a digital simulation of the aircraft dynamics and the guidance and control law are presented for various wind conditions. Author

N77-25150* Kanner (Leo) Associates, Redwood City, Calif
GENERAL STUDY OF LIGHT PLANE SPIN, AFT FUSELAGE GEOMETRY, PART 1

L Beaurain Washington NASA Jun 1977 47 p Transl into ENGLISH of French report, no 77/03 from Institut de Fluides Mecanique de Lille, 28 Feb 1977 p 1-28

(Contract NASw-2790)

(NASA-TT-F-17446) Avail NTIS HC A03/MF A01 CSCL 01C

The effect of aft fuselage geometries on spin is studied in wind tunnel tests on a model. The geometric parameters studied are shape of the fuselage frame, fuselage width, fuselage length and size of the vertical stabilizer. While the shape of the fuselage frame has a very strong effect on the type of spin, the effect of the width and length parameters is only moderate. The results of testing different vertical stabilizer sizes were surprising: reducing the size of the vertical stabilizer often had a beneficial effect on spin. Author

N77-25151* Boeing Vertol Co., Philadelphia, Pa
US ARMY HELICOPTER DESIGN DATCOM VOLUME 1 AIRFOILS Final Report

L U Dadone 31 May 1976 295 p refs

(Contract NAS2-8637)

(NASA-CR-153247 AD-A033425, USAAMRDL-CR-76-2, D210-11097-1-Vol-1) Avail NTIS HC A13/MF A01 CSCL 20/4

This report contains airfoil data of interest for rotor applications. The data is presented in the form of lift, drag, and pitching moment coefficients and, in most cases, it covers the complete Mach number range from low subsonic to supercritical flow conditions. An introductory section presents airfoil data trends and information pertaining to the source and usefulness of such data. GRA

N77-25152* Aeronautical Research Labs., Melbourne (Australia)
THE PERFORMANCE OF AIRCRAFT CONTROL CABLES

UNDER SERVICE CONDITIONS

M B Benoy, R A Fell, and P H Townshend Apr 1977 38 p refs

(ARL/Struc-Note-424) Avail NTIS HC A03/MF A01

Aircraft control cables broken or worn in service were examined. Mechanical tests and theoretical analysis, show the following factors contribute to failure: (1) abrasion of the cables on pulleys or fairleads causing a much more serious loss of strength than is apparent from surface wear, (2) brinelling of the individual wires in the strands due to fluctuating cable tension inducing high contact stresses between helically wound wires. This causes strain-hardening followed by brittleness in the hard-drawn wires leading to the formation of surface cracks, (3) fatigue of wires due to flexing around pulleys and fairleads, and (4) unobserved failure of the core strand due to the combined effects of (2) and (3). Published work on aircraft control cables is reviewed. The development of standards and air-worthiness requirements is discussed. A bibliography, which includes wire ropes in general engineering, is included. Author

N77-25153* Messerschmitt-Boelkow-Blohm G m b H., Ottobrunn (West Germany) Unternehmensbereich Flugzeuge

NON-LINEAR EFFECTS IN AIRCRAFT GROUND AND FLIGHT VIBRATION TESTS

G Haidl 16 Sep 1976 16 p refs Presented at the 43d AGARD Meeting on Struct and Mater Panel, London, 26 Sep - 1 Oct 1976

(MBB-UFE-1273-O) Avail NTIS HC A02/MF A01

Examples of nonlinear vibration behavior in ground resonance tests of an aircraft are shown. Model tests for a simplified system with nonlinear properties were performed to study the effects of friction and backlash with respect to ground resonance test and flight flutter test. With symmetric and asymmetric nonlinear stiffness characteristics effects of amplitude dependent frequencies, mode coupling, mode asymmetries, and the consequences in parameter identification in vibration tests are pointed out and discussed. In case of flutter critical modes the problems of apparent damping caused by nonlinear system properties are shown and recommendations are given to reach a representative flutter clearance with respect to this nonlinear system behavior. Author (ESA)

N77-25154* Messerschmidt-Boelkow G m b H., Ottobrunn (West Germany) Unternehmensbereich Flugzeuge-Entwicklung

WHAT IS THE RIGHT SIZE FOR RPVS?

Bernd Krogull Sep 1976 10 p refs Presented at the Joint Symp on Avionics, Guidance and Control for Remotely Piloted Vehicles at AGARD-Meeting, Florence 4-8 Oct 1976

(MBB-UFE-1272-O) Avail NTIS HC A02/MF A01

Current remotely piloted vehicle (RPV) applications and proposals cover a large range of vehicle size from a few kilograms mass up to full aircraft size. This raises the question whether mini, midi, or maxi RPVs are required for particular military objectives. A broad spectrum of prospective tasks for unmanned vehicles was analyzed and effective and competitive RPV size classes for different missions were identified. It was concluded that there are four distinct unmanned aircraft classes: mini RPV, weighing less than 100 kp, for observation and harassment tasks; midi RPVs in the 500 kp class utilized for air defence suppression and surveillance; somewhat heavier vehicles, in the 1 ton class for combat tasks; and maxi RPVs, weighing more than 2 tons, for special missions. Author (ESA)

N77-25155* Lockheed-California Co., Burbank
OTTAWA STRAY RIG TESTS OF AN ICE PROTECTION SYSTEM APPLIED TO THE UH-1H HELICOPTER Final Report, 20 Jan - 30 May 1976

R H Cotton Nov 1976 97 p refs

(Contract DAAJ02-76-C-0012 DA Proj 1F2-63209-DB-38)

(AD-A034458 LR-27694 USAAMRDL-TR-76-32) Avail NTIS HC A05/MF A01 CSCL 01/3

Simulated icing flight tests were conducted on an advanced ice protection system as applied to an Army UH-1H helicopter in the NRC spray rig at Ottawa, Canada. The system provides for electrothermal cyclic deicing of the main and tail rotor blades, electrically-heated windshield and stabilizer bar, and ice

detectors The aircraft had been tested previously in simulated icing conditions behind the CH-47 HISS A total of 181 hours of testing were accomplished in 54 days at Ottawa Test conditions ranged from 0 deg C to -20 C and liquid water contents equivalent to the recommended atmospheric icing criterion for continuous maximum The deicing controller system demonstrated excellent functioning and reliability characteristics In general, the deicing of the rotor blades was considered to be good Test results were obtained to define recommended heater-on times for deicing as well as heater-off time between cycles Limited tail rotor icing and deicing were evaluated Natural icing flights were planned after system readiness was established but none were made due to the lack of proper weather conditions It is recommended that further testing be accomplished under natural icing conditions to complete the evaluation Prior to this additional testing, another set of heated main rotor blades or modifications to existing blades, incorporating minor design and manufacturing changes, should be procured to preclude recurrence of the heater element-to-erosion shield short problem and other deficiencies noted from the experience to date Author (GRA)

N77-25158# Army Aviation Systems Test Activity Edwards AFB, Calif

OH-58A AUTOROTATIONAL EVALUATION

Joseph C Watts and Vernon L Diekmann 29 Feb 1972 22 p refs

(AD-A035727, USAASTA-71-46) Avail NTIS HC A02/MF A01 CSCL 01/3

Several recent instances of tail-boom buckling have occurred after an autorotational touchdown in the OH-58A helicopter These occurrences prompted the U S Army Aviation System Command (AVSCOM) light observation helicopter (LOH) Project Manager to enter into a product improvement program (PIP) with Bell Helicopter Company (BHC) to define the problem and recommend a solution This PIP task included computer studies a shake test, and flight testing of a structurally instrumented OH-58A helicopter The results of the PIP task, to date, indicate that the tail-boom buckling resulted from a resonant condition between the main rotor and the natural frequencies of the fore and aft pylon mode and the tail boom This resonant frequency, 5 hertz was likely to occur at high blade angles, 100-percent collective, and low rotor speed, 150 RPM and was associated with large main rotor flapping excursions Three solutions were considered (1) change the natural frequencies of the fore and aft pylon mode and/or tail boom, (2) damp the pylon movement, and (3) eliminate the excessive blade flapping The BHC chose the third solution by electing to restrict the maximum collective control travel which would in turn, eliminate excessive flapping at low rotor speeds The BHC testing showed that there was no degradation of helicopter performance as the result of the installation of an 80-percent collective pitch restriction device

GRA

N77-25157# Naval Surface Weapons Center, White Oak Md
RESPONSE OF A-6 LANDING GEAR DOOR TO AIR SHOCK LOADING Final Technical Report, Oct 1975 - Apr 1976

Joseph G Connor Jr 24 Oct 1976 60 p refs
(AD-A035459, NSWC/WOL/TR-76-94) Avail NTIS HC A04/MF A01 CSCL 01/3

Response of an A-6 Aft Main Landing Gear Door to static and transient pressure loads has been calculated with the NASTRAN finite element structural analysis computer code On the basis of manufacturer's static tests these doors have been considered to be the structural items on the plane most sensitive to shock loading Displacements calculated for static loading compare favorably with those measured on tests However examination of the stress distribution in the door panels indicates that the 25 psi shock limit established by the manufacturer is conservative The linear elastic NASTRAN stress calculations indicate that at an altitude of 50,000 ft the door should be able to withstand a 3 psi free-field shock normally incident on its outside surface if the peak stress is not to exceed the yield strength At sea level the door should withstand a free-field shock of 4.3 psi normally incident Author (GRA)

N77-25158# Kaman Aerospace Corp, Bloomfield, Conn
ELASTIC PITCH BEAM TAIL ROTOR Final Report, Aug

1971 - Apr 1976

Paul F Maloney and John D Porterfield Dec 1976 217 p refs

(Contract DAAJ02-72-C-0006)

(AD-A035175, R-1399, USAAMRDL-TR-76-35) Avail NTIS HC A10/MF A01 CSCL 01/3

The objectives of this program were to demonstrate the flight worthiness and to evaluate the reliability and maintainability of the Elastic Pitch Beam tail rotor designed for the UH-1H helicopter This was accomplished by an engineering program which included design, analyses, static testing, fatigue testing, whirl Beam tail rotor on a UH-1H helicopter Author (GRA)

N77-25159# Kaman Aerospace Corp, Bloomfield, Conn
DESIGN OF SELECTED HELICOPTER COMPONENTS FOR EASE OF REPAIR Final Report, Apr. 1975 - May 1976
Thomas N Cook, Frank E Stares, and Charles J Wirth Dec 1976 167 p refs

(Contract DAAJ02-75-C-0029, DA Proj 1F2-62209-AH-76)
(AD-A035152, R-1464, USAAMRDL-TR-76-34) Avail NTIS HC A08/MF A01 CSCL 01/3

This report examines the design of major helicopter components and its effect on the man-hour cost of field repair Recommendations are developed for improving the field repairability of these components on future helicopters through improved applications of current technology and new design concepts The study was accomplished in two phases In the first, field surveys were conducted to identify significantly occurring repair actions in the field and the important elements of each repair task Comments on repair problems were solicited from Army mechanics Nine generic types of components on six helicopter models were investigated Solutions available through improved applications of current technology were identified, and recommended design study projects were submitted for Army approval In Phase 2, design studies were conducted for five generic types of parts found to be most significant from the standpoint of the man-hours they consume in repair and/or the number of complaints they received from mechanics in the field Twenty-five design concepts were investigated Each was subjected to an engineering critique that considered the effects on such factors as cost weight, stress and performance GRA

N77-25160# Calspan Corp Buffalo NY
NORMAL STRESS, TEMPERATURE, AND PERFORMANCE PROPERTIES OF MILITARY AIRCRAFT TIRES Final Report, 6 Feb - 11 Aug 1975

James R Hampton (AFFDL) Oct 1976 104 p ref

(Contract F33615-75-C-0106, AF Proj 1369)

(AD-A036153, CALSPAN-ZM-5689-T AFFDL-TR-76-95) Avail NTIS HC A06/MF A01 CSCL 01/3

Measurements were made of the normal stress and temperature of the 20 x 4.4/12 PR Type VII military aircraft tire while rolled at various speeds On one tire, normal stress was measured at five locations in the tread area at the carcass and tread interface On the second tire the contained air temperature contained air pressure, and the carcass temperature at the carcass and tread interface were recorded Author (GRA)

N77-25161# Rock Island Arsenal, Ill
THE INVESTIGATION OF DYNAMIC GUN POINTING ERRORS FOR HELICOPTER MOUNTED AUTOMATIC CANNON SYSTEMS Final Report, Jul 1975 - Jun 1976

Thomas D Hutchings and Adam R Zak 2 Nov 1976 143 p refs

(DA Proj 1F2-62201-DH-96)

(AD-A035138, RIA-R-TR-76-042) Avail NTIS HC A07/MF A01 CSCL 01/3

In a helicopter-weapon-system, the dynamic gun-pointing errors, caused by the application of weapon recoil forces, are the helicopter airframe vibrations and the relative turret servocontrol oscillations between the interconnected rigid body segments (i.e motions of the azimuth and the elevation drive systems) A two-step analytical procedure has been developed to quantify these errors for different weapon systems and for different operating conditions In this analysis, the airframe dynamics are first determined with a finite-element structural vibration model,

the dynamics of the turret servocontrol system are then determined with a model of the gun and turret. The results of the two models are combined to obtain the dynamic motions of the gun about the initial aim-position. Finally the statistical mean and the standard deviation errors in gun pointing are derived from the dynamic gun vibration patterns. GRA

N77-25162# Bell Helicopter Co., Fort Worth, Tex
ROTOR BLADE FLAPPING CRITERIA INVESTIGATION Final Report, Apr 1975 - Jul 1976

Larry W Dooley Dec 1976 100 p refs
 (Contract DAAJ02-75-C-0030 DA Proj 1F2-62209-AH-76)
 (AD-A034459, USAAMRDL-TR-76-33, Rept-699-099-021)
 Avail NTIS HC A05/MF A01 CSCL 01/3

The objective of this study was to identify helicopter characteristics critical to main rotor flapping and to attempt to establish flapping design criteria. Three helicopter types and three rotor systems were simulated in steady flight at maneuvers using the hybrid version of C81, Rotorcraft flight Simulation Program. Critical operational characteristics were at center of gravity extremes, under low or negative g conditions, with large abrupt control inputs, and in conditions of significant retreating blade stall. Operation outside recommended flight envelopes can cause excessive flapping. Helicopter characteristics influencing flapping were flapping restraint, fuselage stability characteristics, and helicopter loading conditions. A limit flapping criterion is defined the same as current design specifications and should apply for all operations within the recommended flight envelopes of the helicopter. An ultimate flapping criterion is proposed for operations outside the recommended flight envelopes and for failure conditions. The ultimate flapping criterion requires no failure of primary structure due to flapping stop contact and no rotor blade contact with the fuselage for conditions where probability of occurrence is not extremely remote. Author (GRA)

N77-25163# Army Aviation Systems Command, St Louis, Mo
 Systems Analysis Office

REMOTELY PILOTED VEHICLE (RPV) MISSION CAPABILITY CONCEPTS AS RELATED TO US ARMY OPERATION DOCTRINE Final Report

Richard A Radtke 12 Nov 1976 18 p
 (AD-A035392, DRSAB-D-76-13 USAVSCOM-TR-77-2) Avail
 NTIS HC A02/MF A01 CSCL 01/3

A review of Field Manual FM 100-5 Operations, 1 July 1976 has been made to determine those basic concepts of Army Operational capabilities outlined in the coordinated US Army Intelligence Center and School (USAICS) preliminary RPV Operational and Organizational (O and O) Concepts June 1976. GRA

N77-25165# Rockwell International Corp., Columbus, Ohio
 Aircraft Div

ON-WATER MOTION RELATIONSHIPS STUDY Final Report, 17 Aug 1976 - 15 Jan 1977

James D Aurand 15 Jan 1977 100 p refs
 (Contract N00600-76-C-1606)
 (AD-A035344, NR76H-137) Avail NTIS HC A05/MF A01 CSCL 01/3

This report presents an on-water head seas motion analysis of three C/STOL and three V/STOL sea based aircraft configurations. Heave pitch acceleration, and slamming/wetness conditions are determined. Different forward speed conditions were studied. The effect of various configuration parameters (length, inertia, c.g. location, water plane area, etc.) on head seas motion parameters was established. Sea state conditions from one to seven were studied. Fundamental sea state relationships and their effect on sea basing of aircraft are presented. Recommendations for subsequent model tank testing are indicated. GRA

N77-25169# Bell Helicopter Co., Fort Worth, Tex
AH-1G HELICOPTER AERODYNAMIC AND STRUCTURAL LOADS SURVEY Final Report, Jun. 1974 - Apr. 1976

Gerald A Shockey, Joe W Williamson, and Charles R Cox Feb 1977 365 p refs
 (Contract DAAJ02-73-C-0105, DA Proj 1F2-62209-AH-76)
 (AD-A036910, Rept-699-099-017, USAAMRDL-TR-76-39)
 Avail NTIS HC A16/MF A01 CSCL 01/1

Accurate prediction of helicopter system loadings required detailed knowledge of rotor aerodynamic environments and structural dynamic responses. This report describes a flight test program of an AH-1G helicopter where airfoil surface pressure, leading edge stagnation point, local flow magnitude and direction, blade accelerations, bending moments and the attendant responses in the control system and airframe were measured simultaneously. The hardware development instrumentation techniques, test conditions, and initial data analyses are discussed. The development of a rotating frequency-division multiplex, capable of regulating and conditioning over 300 transducer signals and the component testing and calibration of those transducers are described. Samples are presented of pressure distributions, leading edge stagnation point versus azimuth and surface flow magnitude and direction. Aerodynamic forces and responses in the rotor and control systems are presented and compared with predicted analytical values. Acoustic signals and airload fluctuations are used to locate and define the origin of rotor noise during high-speed flight and in operating regimes of strong wake interaction. GRA

N77-25170# Air Force Academy, Colo
PRESSURE DRIVEN ANGLE OF ATTACK INDICATING SYSTEM Final Report, Mar 1972 - Mar 1975

Roger W Gallington and James W Christian Jan 1976 101 p refs
 (AF Proj 7905, ILIR Proj 74-11)
 (AD-A035321, AFATL-TR-76-10) Avail NTIS
 HC A06/MF A01 CSCL 01/4

Technically inclined flyers have long recognized the importance to the pilot of angle of attack information. Unfortunately, a reliable, accurate, and low cost angle of attack indicator has not been available. From the outset the goal of this research has been to develop an angle of attack indicator as simple, accurate, reliable, and inexpensive as the common airspeed indicator so that it could be used as a primary landing approach aid and for the other flight control functions. This report describes the solution to that problem. GRA

N77-25171*# Boeing Co., Seattle, Wash
A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS OF AIRCRAFT GAS TURBINE ENGINES. VOLUME 1 METHOD OF ANALYSIS Final Report

R J Pera, E Onat, G W Klees, and E Tjonneland May 1977 50 p refs
 (Contract NAS3-19913)
 (NASA-CR-135170, D6-44258-Vol-1) Avail NTIS
 HC A03/MF A01 CSCL 21E

Weight and envelope dimensions of aircraft gas turbine engines are estimated within plus or minus 5% to 10% using a computer method based on correlations of component weight and design features of 29 data base engines. Rotating components are estimated by a preliminary design procedure where blade geometry, operating conditions, material properties, shaft speed, hub-tip ratio, etc., are the primary independent variables used. The development and justification of the method selected, the various methods of analysis, the use of the program, and a description of the input/output data are discussed. Author

N77-25172*# Boeing Co., Seattle, Wash
A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS OF AIRCRAFT GAS TURBINE ENGINES. VOLUME 2 USER'S MANUAL Final Report

R J Pera, E Onat, G W Klees, and E Tjonneland May 1977 42 p refs
 (Contract NAS3-19913)

(NASA-CR-135171, D6-44258-Vol-2) Avail NTIS
HC A03/MF A01 CSCL 21E
For abstract, see N77-25171

N77-25173# Boeing Co., Seattle Wash
**A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS
OF AIRCRAFT GAS TURBINE ENGINES VOLUME 3
PROGRAMMER'S MANUAL Final Report**
R J Pera E Onat, N L Prewitt, G W Klees, and E Tjonneland
May 1977 167 p
(Contract NAS3-19913)
(NASA-CR-135172, D6-44258-Vol-3) Avail NTIS
HC A08/MF A01 CSCL 21E
For abstract, see N77-25171

N77-25175# Boeing Aerospace Co., Seattle Wash
**INTEGRATED PROPULSION CONTROL SYSTEM (IPCS)
VOLUME 1 SUMMARY Final Technical Report, 1 Mar -
30 Aug 1976**
Leon O Billig Aug 1976 39 p
(Contract F33615-73-C-2035)
(AD-A032439, AFAPL-TR-76-61-Vol-1) Avail NTIS
HC A03/MF A01 CSCL 21/5

The Integrated Propulsion Control System (IPCS) program was conducted to pursue and demonstrate the advantages of integrated propulsion controls. The program encompassed the design build, flight qualification, and flight testing of control modes, software, and hardware. The flight test vehicle was an F-111E. The left inlet and TF30-P-9 engine were modified to operate under control of an HDC-601 computer. Two sets of hardware were built or modified and two sets of software were developed. One implemented the bill-of-materials control laws and one implemented control laws developed under contract. A step-by-step sequence of tests of increasing complexity demonstrated suitability for flight. Fifteen flights were conducted to evaluate the IPCS. The program description and results are summarized in this document. Author (GRA)

N77-25176# Boeing Aerospace Co., Seattle, Wash
**INTEGRATED PROPULSION CONTROL SYSTEM
VOLUME 4 METHODOLOGY Final Technical Report, 1 Mar
1973 - 30 Aug 1976**
Leon O Billig Aug 1976 114 p refs
(Contract F33615-73-C-2035)
(AD-A033062, AFAPL-TR-76-61-Vol-4) Avail NTIS
HC A06/MF A01 CSCL 21/5

The IPCS program proved that the operational capability of aircraft can be expanded by use of integrated propulsion controls. The techniques employed to achieve this improved performance include (1) early planning for integration, (2) early involvement of all concerned parties, and (3) freer communication, down to the working engineer level, than is considered common. Proper use and management of these three items constitutes the IPCS methodology. The goal of the methodology document is to provide assistance in establishing the philosophy and direction that will minimize program risk and cost. Author (GRA)

N77-25177# Lockheed-Georgia Co., Marietta
**THE GENERATION AND RADIATION OF SUPERSONIC JET
NOISE VOLUME 2 STUDIES OF JET NOISE, TURBU-
LENCE STRUCTURE AND LASER VELOCIMETRY Final
Technical Report, 6 Nov 1972 - 6 Nov. 1976**
Harry E Plumblee, Jr., ed., Robert H Burrin, Jark C Lau,
Christopher L Morfey, Philip J Morris, David M Smith, H K
Tanna, Bria J Tester, and M Clay Whiffen 23 Jun. 1976
460 p refs Sponsored in part by DOT
(Contract F33615-73-C-2032 AF Proj 3066)
(AD-A032881, LG76ER0133-Vol-2 AFAPL-TR-76-65-Vol-2)
Avail NTIS HC A20/MF A01 CSCL 20/1

This volume discusses (1) turbulent mixing noise tests and observations relative to effects of temperature and Mach number on intensity, directivity, and spectra, (2) numerical solutions of the Lilley theory for sound radiated from point sources simulating small-scale turbulence noise sources, and comparisons of these solutions with experimental data relating to temperature and velocity effects on directivity and spectra, (3) the theory

describing the development of the large-scale coherent motion of the jet structure and the far-field noise radiated from this turbulence (4) a detailed discussion and interpretation of the jet turbulence and mean velocity data and (5) a comprehensive description of the shock-associated noise tests a preliminary description of the broadband shock-associated noise model, and a discussion of shock-associated noise in the overall jet noise picture. GRA

N77-25178# Lockheed-Georgia Co., Marietta
**THE GENERATION AND RADIATION OF SUPERSONIC JET
NOISE VOLUME 3 TURBULENT MIXING NOISE DATA
Final Technical Report, 6 Nov 1972 - 6 Nov 1975**
H K Tanna, Peter D Dean and Robert H Burrin 23 Jun
1976 472 p Sponsored in part by DOT
(Contract F33615-73-C-2032 AF Proj 3066)
(AD-A032882, LG76ER0133-Vol-3, AFAPL-TR-76-65-Vol-3)
Avail NTIS HC A20/MF A01 CSCL 20/1

The characteristics, both spectral and directivity, of the sound field of supersonic shock-free jets are studied by measuring the turbulent mixing noise in the far field from four two-inch diameter nozzles namely a convergent nozzle for pressure ratios up to critical and three convergent-divergent nozzles having nominal design Mach numbers of 1.4, 1.7, and 2.0, respectively. The measurements were conducted in a free-field environment. The results from 75 jet exit conditions are presented in a systematic manner in the form of tabulated one-third octave spectra. The test program was carefully planned in order to obtain results (1) at constant jet efflux temperature with varying jet velocity, and conversely (2) at constant exit velocity while varying jet efflux temperature. The effects of jet velocity and exhaust temperature on turbulent mixing noise can therefore be assessed independently. GRA

N77-25179# Lockheed-Georgia Co., Marietta
**THE GENERATION AND RADIATION OF SUPERSONIC JET
NOISE VOLUME 4 SHOCK-ASSOCIATED NOISE DATA
Final Technical Report, 6 Nov 1972 - 6 Nov. 1975**
H K Tanna, Peter D Dean, and Robert H Burrin 23 Jun
1976 416 p Sponsored in part by DOT
(Contract F33615-73-C-2032, AF Proj 3066)
(AD-A032883, LG76ER0133-Vol-4, AFAPL-TR-76-65-Vol-4)
Avail NTIS HC A18/MF A01 CSCL 20/1

The characteristics of the sound field of shock-containing under-expanded jets are studied by measuring the noise from a two-inch diameter convergent nozzle over an extensive envelope of supercritical jet operating conditions. The measurements, which are accurate and comprehensive, were conducted in the Lockheed anechoic facility. The results are presented in this volume in a systematic manner in the form of narrowband spectra. The details pertinent to the experimental program and the data presentation format are summarized below. The total noise spectrum from an incorrectly expanded jet flow contains discrete components (or screech) in addition to the basic turbulent mixing noise and the broadband shock-associated noise. In order to study the trends and dependencies of the broadband component accurately, it is vital to keep the contamination by screech to a minimum in the experimental program. In the present experiments, screech suppression was successfully achieved by wrapping all surfaces surrounding the nozzle exit with sound absorbing material, and incorporating a small projection inside the nozzle lip. This projection interrupts the feedback loop between the first shock and the nozzle exit plane, which has been previously proposed and verified as the physical mechanism of screech generation. The detailed calibration tests, conducted prior to the main shock-associated noise experiments, established that all results are essentially uncontaminated by the presence of screech. GRA

N77-25180# Pennsylvania State Univ., University Park Applied
Research Lab
**NOISE DUE TO INTERACTION OF BOUNDARY LAYER
TURBULENCE WITH A COMPRESSOR OR A PROPULSER
MOTOR**
N Morosov, B Lakshminarayana and D E Thompson 27 Aug
1976 50 p refs
(Contract N00017-73-C-1418)

(AD-A033199, TM-76-241) Avail NTIS HC A03/MF A01 CSCL 20/4

The radiated sound due to a compressor or propulsor rotating blade row was investigated under various operating conditions and inflows. The propulsor was operated in air with different blade space-to-chord ratios, different flow coefficients and differing turbulence (non-isotropic) inflows. The inflows ingested are (1) the natural boundary layer on the hub and annulus wall, (2) a tripped boundary layer on the hub, and (3) a fully developed boundary layer on the hub. The turbulence properties were also altered by placing a grid at the inlet. The mean velocity profiles, turbulence intensities, length scales, and energy spectra of the inflow were measured, as well as near and far-field acoustic spectra. A parametric investigation of the effect of inflow characteristics on the radiated sound has been made. Several length scales were found to exist simultaneously. The noise due to small scale turbulence seems to depend on, i.e., turbulence velocity normal to the blade divided by the axial length scale. The long eddies are also responsible for discrete tone production.

Author (GRA)

N77-25181# General Electric Co., Wilmington, Mass Dept of Aerospace Instruments and Product Support
SOLID STATE VERTICAL SCALE INDICATOR FOR ENGINE PERFORMANCE INDICATION Final Report, 13 Nov. 1976 - 28 Sep 1976

G M Gozamba and R L Skovholt Oct 1976 26 p
(Contract N62269-76-C-0109)
(AD-A036154, DF6AEE228, NADC-75219-50) Avail NTIS HC A03/MF A01 CSCL 01/4

The work performed on an evaluation sample of a totally solid state engine performance instrument is presented. The particular application is a six channel indicator with each parameter displayed as a bargraph and a redundant numeric. The display medium is gallium arsenide phosphide (GaAsP) LED emitting light in the red spectrum. Emphasis is given on characteristics and the performance of an evaluation unit.

Author (GRA)

N77-25182# Naval Air Test Center Patuxent River Md
AIRCRAFT ENGINE DRIVEN ACCESSORY SHAFT COUPLING IMPROVEMENTS USING HIGH-STRENGTH, LOW WEAR POLYIMIDE PLASTIC

Aleck Loker 30 Dec 1976 34 p refs
(AD-A035301, NATC-TM-76-1-SY) Avail NTIS HC A03/MF A01 CSCL 21/5

Splined shaft couplings which connect generators, pumps, starters, and other accessories to aircraft engines and gearboxes frequently exhibit high wear and failure rates. In an effort to improve aircraft safety, reliability, and readiness the Naval Air Test Center has engaged in a continuing spline improvement program over the past 9 years. This Technical Memorandum describes the development and test of two unique spline coupling modifications which have proven to be essentially immune to wear and failure, in the aircraft power transmission applications which have been evaluated. Specific design information and application concepts are discussed to introduce this new spline coupling technology to mechanical equipment designers.

Author (GRA)

N77-25183# Southwest Research Inst., San Antonio, Tex
INVESTIGATION OF GREASE-LUBRICATED EXPENDABLE SPLINE CONNECTIONS Final Report, Jan 1975 Oct. 1976

M L Valtierra 20 Oct 1976 60 p refs
(Contract N68335-75-C-1117)
(AD-A035296 SwRI-RS-650) Avail NTIS HC A04/MF A01 CSCL 21/5

The objective of this program was to evaluate the feasibility of three basic arrangements of expendable spline connections namely the 'standard', the 'dogbone' and the 'muff' splines. Spline wear tests were performed with three SwRI spline wear testers, operated under controlled angular misalignment, torque, temperature, and speed conditions, using a MIL-G-81322B grease. Standard, dogbone and muff spline test specimens of various material and hardness combinations were used some with varied metallic coatings and designs. The basic objective of this program

was accomplished, i.e., to show that the 'expandable spline' concept can be used to advantage, to extend the wear life of 'grease-lubricated steel interface spline connections' GRA

N77-25184# General Motors Corp., Indianapolis, Ind Detroit Diesel Allison Div

VARIABLE CYCLE ENGINE CONTROL SYSTEM DEFINITION STUDY TURBINE ENGINE TECHNOLOGY DEMONSTRATOR COMPONENT DEVELOPMENT PROGRAM, PROJECT 678A CONTROLS DEVELOPMENT PROGRAM Final Technical Report, Jul 1973 - Mar 1976

Robert C Boxer and Jay D Meador Mar 1976 198 p
(Contract F33657-73-C-0618, AF Proj 668A)

(AD-A036175, DDA-EDR-8836, AFAPL-TR-76-49) Avail NTIS HC A09/MF A01 CSCL 21/5

The primary objective of this Air Force funded program was the development of a control mode for a Joint Technology Demonstrator (JTD) engine that achieves optimal steady state performance (minimum sfc and maximum thrust) with rapid transient performance over the entire flight envelope of a hypothetical transonic/supersonic aircraft. A flexible digital computer simulation of the JTD turbofan engine with a control system was developed along with computerized optimization and constraint procedures to establish optimal engine operating conditions and variable geometry positions to achieve minimum sfc and maximum thrust. Speed and turbine temperature fuel governors along with a compressor Mach Number (delta P/P) surge control loop in the fuel control were evaluated. A control mode that positioned the geometry to 'scheduled' optimal geometry settings was unable to achieve steady state maximum thrust over the entire flight envelope. However, a control mode developed to force engine parameters to 'scheduled' optimal parametric relationships successfully attained minimum sfc and maximum thrust at all the selected test points in the flight envelope. Since certain parametric relationships are true for minimum sfc (i.e., maximum airflow and minimum temperature for a given thrust) and maximum thrust (i.e., maximum speed, temperature, and pressure within engine limits), the control based upon parametric relationships will yield maximum thrust and near minimum sfc for a reasonable range of engine variation. Therefore, it is not necessary to tune each new engine for maximum thrust or adjust the control for engine aging. GRA

N77-25187# Boeing Vertol Co Philadelphia, Pa
TRANSMISSION CONDITION ASSESSMENT Final Report O L Sandora Dec 1976 183 p refs
(Contract DAAJ02-75-C-0021)

(AD-A035215, D210-11067-1, USAAMRDL-TR-76-36) Avail NTIS HC A09/MF A01 CSCL 13/9

This program was conducted to provide the correlation and analysis of vibration signatures, component condition and oilborne debris from 38 CH-47C rotor transmissions tested under a spectrum of load conditions. The transmission tested included new postoverhaul and preoverhaul scheduled and unscheduled removals. The analysis of data shows the relative diagnostic accuracies of transmission condition assessment by analysis of particulate debris from filters and by spectral analysis of demodulated high-frequency vibration. Author (GRA)

N77-25188# RAND Corp Santa Monica, Calif
STRATEGIC DEFENSE MATERIALS A CASE STUDY OF HIGH TEMPERATURE ENGINES Interim Report

Richard G Salter, Corey Dztzer Elwyn D Harris William E Mooz, and Kathleen A Wolf Feb 1977 103 p refs
(Contract DAHC15-73-C-0181 ARPA Order 189)

(AD-A037493, R-1970-ARPA) Avail NTIS MF A01 CSCL 05/1

Recent short-term commodity shortages and the potential for interruption of our supplies have caused concern that future U.S. defense systems may become increasingly dependent on materials that are potentially in short supply. This study inquires specifically into the prospects for material to be applied in the first stage turbine of man-rated military aircraft in 1990. The set of candidate material technologies that are in prospect is defined, and the component materials of these technologies that are potentially future supply problems are determined. A

methodology was developed to combine the range of technology risks with the range of materials availability risks and overall comparisons were made. Due to the significant availability risks of chromium (as a necessary constituent of superalloys), ceramic materials appear to have the lowest long-term risks for high temperature engines. Author (GRA)

N77-25189# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va
ANALYSIS OF SEPARATION OF THE SPACE SHUTTLE ORBITER FROM A LARGE TRANSPORT AIRPLANE
 Alan W Wilhite Jun 1977 24 p refs
 (NASA-TM-X-3492, L-11074) Avail NTIS HC A02/MF A01 CSCL 01D

The feasibility of safely separating the space shuttle orbiter (140A/B) from the top of a large carrier vehicle (the C-5 airplane) at subsonic speeds was investigated. The longitudinal equations of motion for both vehicles were numerically integrated using a digital computer program which incorporates experimentally derived interference aerodynamic data to analyze the separation maneuver for various initial conditions. Separation of the space shuttle orbiter from a carrier vehicle was feasible for a range of dynamic-pressure and flight-path-angle conditions. By using an autopilot, the vehicle attitudes were held constant which ensured separation. Carrier-vehicle engine thrust, landing gear, and spoilers provide some flexibility in the separation maneuver. Author

N77-25198# Army Engineer Waterways Experiment Station Vicksburg, Miss Soils and Pavements Lab
SUMMARY OF BUCKLING AND TENSION TESTS OF LANDING MATS AS RELATED TO C-5A AIRCRAFT BOW WAVE PROBLEMS Final Report, Jan - Jun 1976
 Hugh L Green and Carroll J Smith Jan 1977 48 p refs
 (DA Proj 1T1-62112-A-528)
 (AD-A037000, WES-MP-S-77-1) Avail NTIS HC A03/MF A01 CSCL 01/5

In order to better understand and define the problems associated with the C-5a and landing mat, several investigations were conducted at the U S Army Engineer Waterways Experiment Station and Utah State University to study the characteristics of landing mats subjected to horizontal C-5A loads. Several mat configurations with various connector designs were evaluated in buckling skid, joint slack and traffic tests. Mats both with and without water seals were used in the tests; however, the heavy-duty truss web mat designs with their extra weight and additional strength were given primary consideration. In the buckling tests conducted, it was determined that panel width, mat unit weight, and formation width were factors which affect the buckling load of a mat system. The horizontal load at which buckling occurs depends almost exclusively on the vertical eccentricities existing in the mat system at the time the load is applied. These eccentricities or irregularities could be initiated by the presence of warped panels, damaged joints, uneven subgrade, etc. It is concluded that the approximately square truss web mat designs sustained a much higher load per foot of width prior to the development of a bow wave or buckling. Square mats without water seals give higher resistance to sliding between mat rows than mats with seals. However, membrane beneath mat provides a lower coefficient of friction which enhances mat sliding. During the normal placement of mat, there is free slack in the panel joints which, although necessary for contraction and expansion, contributes to potential runway movement. GRA

N77-25236# McDonnell-Douglas Corp., St Louis, Mo
SPACE SHUTTLE ENGINEERING AND OPERATIONS SUPPORT. AVIONICS SYSTEM ENGINEERING
 P A Broome, R J Neubaur, and R T Welsh 20 May 1976 62 p refs
 (Contract NAS9-14960)
 (NASA-CR-151364, Rept-1.3-DN-C0712-003) Avail NTIS HC A04/MF A01 CSCL 22A

The shuttle avionics integration laboratory (SAIL) requirements for supporting the Spacelab/orbiter avionics verification process are defined. The principal topics are a Spacelab avionics hardware assessment, test operations center/electronic systems test

laboratory (TOC/ESL) data processing requirements definition, SAIL (Building 16) payload accommodations study, and projected funding and test scheduling. Because of the complex nature of the Spacelab/orbiter computer systems, the PCM data link and the high rate digital data system hardware/software relationships, early avionics interface verification is required. The SAIL is a prime candidate test location to accomplish this early avionics verification. Author

N77-25256# Goldsworthy Engineering, Inc., Torrance, Calif
MM AND T-PULTRUDED COMPOSITE STRUCTURAL ELEMENTS Final Report
 Brian H Jones and William Jakway Dec 1976 124 p refs
 (Contract DAAJ02-74-C-0053)
 (AD-A035217, USAAMRDL-TR-76-5) Avail NTIS HC A06/MF A01 CSCL 11/4

The objectives of this program were to establish the manufacturing technology base in order to pultrude with a range of resin matrices and reinforcing forms to investigate the post-forming capability of epoxy matrix pultrusions, and to derive a representative range of static and fatigue mechanical property design allowables. Additionally, structural efficiency studies were performed to evaluate the potential advantages of using pultruded substructural elements. It was concluded that even using existing epoxy system, pultrusion is a highly viable process that results in structures possessing good mechanical properties at potentially low cost. Post-forming operations may be readily carried out, which further enhances the potential application areas for the technique. Author (GRA)

N77-25261# Boeing Aerospace Co., Seattle, Wash
DEVELOPMENT OF A LOW-COST GRAPHITE REINFORCED COMPOSITE PRIMARY STRUCTURAL COMPONENT Final Report, May 1974 - Sep 1976
 John H Laakso and John T Hoggatt Dec 1976 166 p refs
 (Contract N622669-74-C-0368)
 (AD-A035398, D180-18236-5) Avail NTIS HC A08/MF A01 CSCL 10/3

In two preceding NAVAIR programs, materials and processes studies indicated graphite reinforced polysulfone (Gr/Ps) composites have potential cost saving benefits for aircraft structure. Based on the encouraging results of the preceding programs, the Navy funded a joint Boeing/Navy program to take the next developmental step to build and evaluate some Gr/Ps primary aircraft structural components. The Boeing portion of the program, which is summarized in this report, consisted of Design Studies, Material and Process Studies, Structural Element and Subcomponent Testing, Prototype Component Fabrication and Delivery, Component Test Planning, Comparative Cost Analysis, Post-test Component Analysis. The prototype Gr/Ps components were designed, for demonstration purposes and low program cost, to replace the aluminum centerbody skins of the XBQM-34E Supersonic Firebee Target drone built by Teledyne Ryan Aeronautical. Comparative cost analyses were performed on preliminary designs prepared for a hypothetical large-scale aircraft fuselage panel using (1) conventional aluminum and (2) graphite-reinforced thermoplastic design concepts. A 20 percent cost saving was offered by the thermoplastic design concept in a 100-unit production run along with a 16 percent weight saving. Ground testing of the Gr/Ps components installed on a XBQM-34E airframe was performed. The components sustained the limit load condition associated with chute recovery (the critical design condition) without damage. Post-test analysis of the measured strains indicates that the load capabilities of the >Gr/Ps components exceed their ultimate load requirements. GRA

N77-25265# Naval Research Lab., Washington, D C
HIGH PERFORMANCE COMPOSITES AND ADHESIVES FOR V/STOL AIRCRAFT Annual Report, 1 Jul 1975 - 1 Sep 1976
 Wilford D Bascom and Luther B Lockhart, Jr Dec 1976 124 p refs
 (WF54593201)
 (AD-A035928, NRL-MR-3433, AR-1) Avail NTIS HC A06/MF A01 CSCL 11/4

An interdisciplinary program has been undertaken to address the composite and adhesive materials requirements of V/STOL aircraft. The primary tasks are to develop and characterize high modulus high toughness resins with use temperatures of 350 F to 450 F or higher to develop fabrication technology for newly developed resin matrices for graphite-fiber reinforced composites, to develop composite failure criteria for design optimization and to establish appropriate quality control parameters. The principal accomplishments to date have been to demonstrate (a) the variation in mechanical properties obtainable by the molecular tailoring of polyphthalocyanine resins, (b) the effectiveness of NMR spectroscopy for chemical characterization of resins of complex composition, (c) the viability of resin cure using ionizing radiation and (d) the development of a unique approach to determining failure criteria for flaw growth in resin matrix composites. Author (GRA)

N77-25311# National Aerospace Lab Amsterdam (Netherlands) Structures and Materials Div

ALUMINIUM ALLOY DEVELOPMENT AND EVALUATION FOR AIRCRAFT STRUCTURAL PERFORMANCE

R J H Wanhill and G F J A VanGestel Aug 1976 31 p refs Presented at the Intern Meeting on Aluminium Alloys in the Aircraft Ind Turin, 1-2 Oct 1976

(NLR-MP-76022-U) Avail NTIS HC A03/MF A01

The fatigue strength, fatigue crack propagation resistance, stress corrosion resistance, fracture toughness and residual static strength of aluminum alloys and structures for aircraft are reviewed. The most outstanding problem is whether 7000 series alloys can be used to achieve weight savings in structures customarily made from 2000 series alloys while maintaining or improving durability and damage tolerance. It is concluded that sandwich and laminated panel constructions will be favored for 7000 series alloys. Author (ESA)

N77-25345*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio

THERMAL STABILITY OF SOME AIRCRAFT TURBINE FUELS DERIVED FROM OIL SHALE AND COAL

Thaine W Reynolds Washington Jun 1977 33 p refs (NASA-TM-X-3551 E-9070) Avail NTIS HC A03/MF A01 CSDL 21D

Thermal stability breakpoint temperatures are shown for 32 jet fuels prepared from oil shale and coal syncrudes by various degrees of hydrogenation. Low severity hydrotreated shale oils, with nitrogen contents of 0.1 to 0.24 weight percent, had breakpoint temperatures in the 477 to 505 K (400 to 450 F) range. Higher severity treatment lowering nitrogen levels to 0.008 to 0.017 weight percent resulted in breakpoint temperatures in the 505 to 533 K (450 to 500 F) range. Coal derived fuels showed generally increasing breakpoint temperatures with increasing weight percent hydrogen, fuels below 13 weight percent hydrogen having breakpoints below 533 K (500 F). Comparisons are shown with similar literature data. Author

N77-25392# Rome Air Development Center Griffiss AFB, NY
AN ARRAY TECHNIQUE FOR ZENITH TO HORIZON COVERAGE

William G Mavroides and Robert J Mailloux Nov 1976 24 p refs (AF Proj 4600) (AD-A035503, RADC-TR-76-360) Avail NTIS HC A02/MF A01 CSDL 17/2

This report describes a new concept in wide-angle coverage arrays and has application to the problem of providing low-cost efficient antennas with hemispherical coverage for aircraft-to-satellite communication links. The combined array surface-wave antenna consists of 64 waveguide elements conventionally scanned, except at endfire. At endfire the array is shorted to become a corrugated surface-wave antenna and is excited by an 8-element feed to provide a directional beam near the horizon. The array is rotated to give hemispherical coverage. GRA

N77-25581*# Lockheed-California Co, Burbank
EVALUATION OF STRUCTURAL DESIGN CONCEPTS FOR AN ARROW-WING SUPERSONIC CRUISE AIRCRAFT

I F Sakata and G W Davis Washington NASA Apr 1977 138 p refs (Contract NAS1-12288) (NASA-CR-2667, LR-27832) Avail NTIS HC A07/MF A01 CSDL 01C

An analytical study was performed to determine the best structural approach for design of primary wing and fuselage structure of a Mach 2.7 arrow wing supersonic cruise aircraft. Concepts were evaluated considering near term start of design. Emphasis was placed on the complex interactions between thermal stress, static aeroelasticity, flutter fatigue and fail safe design, static and dynamic loads and the effects of variations in structural arrangements, concepts and materials on these interactions. Results indicate that a hybrid wing structure incorporating low profile convex beaded and honeycomb sandwich surface panels of titanium alloy 6Al-4V were the most efficient. The substructure includes titanium alloy spar caps reinforced with boron polyimide composites. The fuselage shell consists of hat stiffened skin and frame construction of titanium alloy 6Al-4V. A summary of the study effort is presented and a discussion of the overall logic, design philosophy and interaction between the analytical methods for supersonic cruise aircraft design are included. Author

N77-25681# National Aerospace Lab, Amsterdam (Netherlands) Scientific Services

ANALYSIS OF THE NLR AIRPORTS POLLUTION DISPERSION MODEL ON SENSITIVITY FOR METEOROLOGICAL PARAMETERS AND ON SOURCE MODELING

J J Tiggelaar 7 Dec 1976 32 p refs (NLR-TR-75014-U) Avail NTIS HC A03/MF A01

It was found that the weather resolution of the model is satisfactory in view of the present standards of meteorological measurement. Atmospheric stability (Pasquill class) turned out to be the parameter that influences the pollution dispersion most, especially through its influence on vertical dispersion rate. For long term prediction of pollution levels, where mean values of weather parameters are more accurately known, the meteorological modeling is most appropriate. To treat real airplanes, which do not emit continuously (e.g. if above the inversion layer, emitted pollution does not reach the ground) the Gaussian plume was modified into a cut-off plume. Then modeling of the polluting airplanes by series of moving point sources using the cut-off plume, was compared with modeling them by a line source representing their averaged emission. It was found that deviations are important only in close vicinity of taxi and flight tracks, e.g. on the airport itself. Thus for applications to the surroundings of airports, the line source modeling present in the model, is adequate. Author (ESA)

N77-25912*# DyTec Engineering, Inc, Huntington Beach Calif
RECOMMENDED PROCEDURES FOR MEASURING AIRCRAFT NOISE AND ASSOCIATED PARAMETERS

Alan H Marsh Apr 1977 164 p refs (Contract NAS1-12436) (NASA-CR-145187, DyTec-R-0176) Avail NTIS HC A08/MF A01 CSDL 20A

Procedures are recommended for obtaining experimental values of aircraft flyover noise levels (and associated parameters). Specific recommendations are made for test criteria, instrumentation, performance requirements, data-acquisition procedures and test operations. The recommendations are based on state-of-the-art measurement capabilities available in 1976 and are consistent with the measurement objectives of the NASA Aircraft Noise Prediction Program. The recommendations are applicable to measurements of the noise produced by an airplane flying subsonically over (or past) microphones located near the surface of the ground. Aircraft types covered by the recommendations are fixed-wing airplanes powered by turbojet or turbofan engines and using conventional aerodynamic means for takeoff and landing. Various assumptions with respect to subsequent data processing and analysis were made (and are described) and the recommended measurement procedures are compatible with the assumptions. Some areas where additional research is needed relative to aircraft flyover noise measurement techniques are also discussed. Author

N77-25915*# National Aeronautics and Space Administration
Langley Research Center, Langley Station Va

**A REVIEW OF CURRENT PROCEDURES FOR NORMALIZ-
ING AIRCRAFT FLYOVER NOISE DATA TO REFERENCE
METEOROLOGICAL CONDITIONS**

Richard DeLoach Washington May 1977 14 p refs
(NASA-TN-D-8406, L-10471) Avail NTIS HC A02/MF A01
CSCL 20A

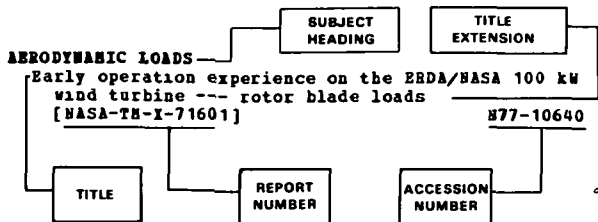
Procedures that are currently used to normalize raw aircraft noise data to reference weather conditions are reviewed These procedures sometimes result in calculated values of molecular absorption which differ from measured values especially at higher frequencies An explanation is offered for this discrepancy and its effect on normalized sound levels and on calculations of effective perceived noise level is examined Author

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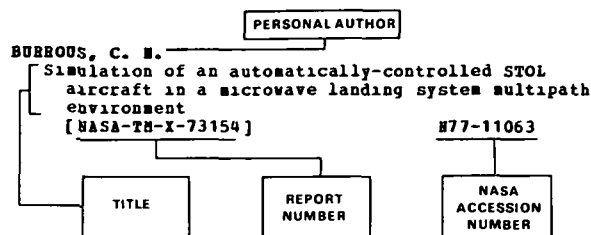
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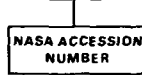
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